VOLUME XXXVI NO. 190 JANUARY-FEBRUARY 1952

LAND
SEA
AIR

ORDNANCE

DR. ALLEN V. ASTIN
Acting Director,
The National
Bureau of Standards

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★ Weapons for the Navy . . . . Rear Adm. M. F. Schoeffel
★ Air Power and Research . . . . Maj. Gen. Fred. R. Dent, Jr.
★ Blueprint for Preparedness . . . . . C. E. Wilson

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FAITH is our greatest source of national strength.

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Vol. XXXVI JANUARY-FEBRUARY, 1952 No. 190

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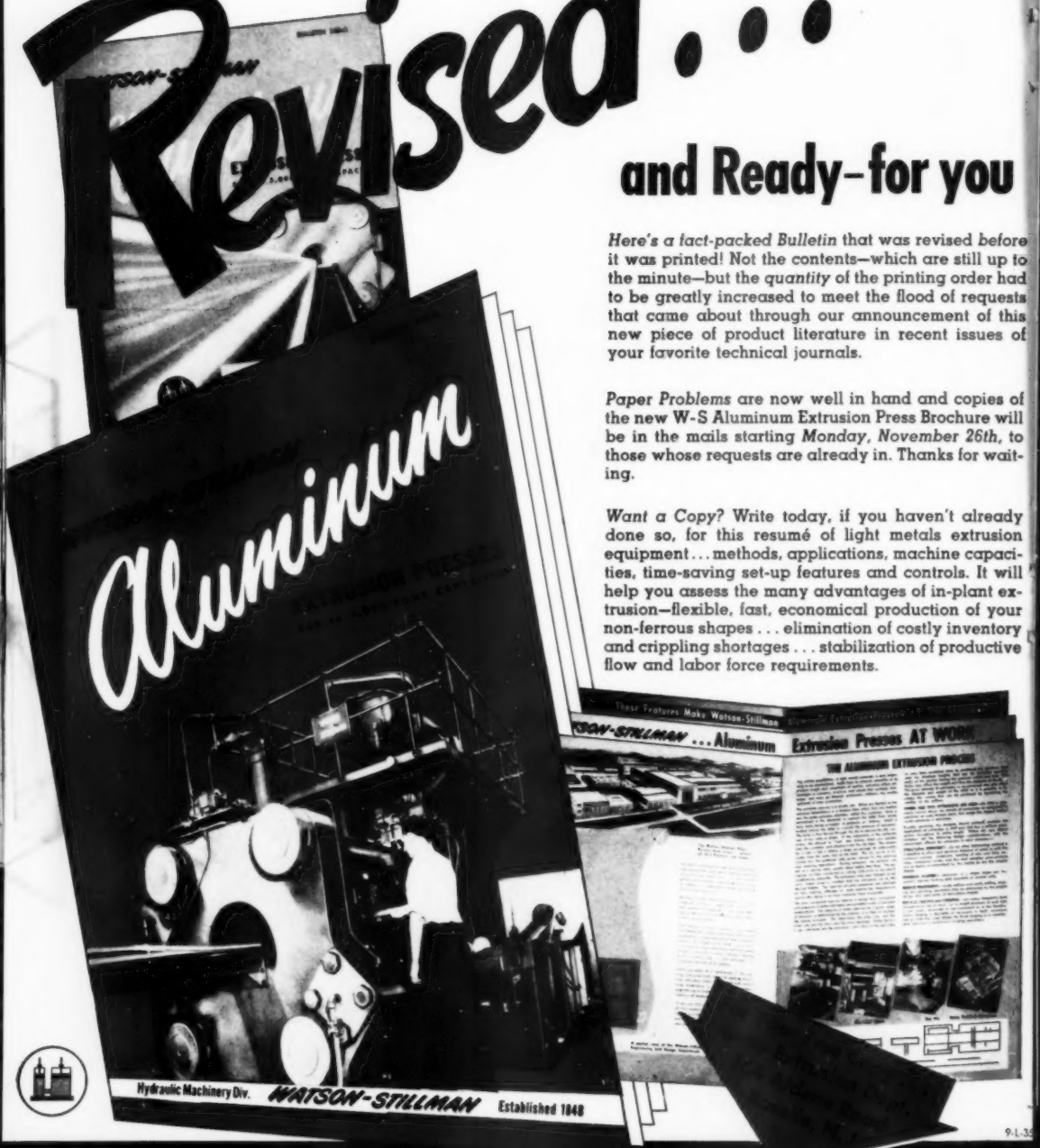
Revised . . .

and Ready–for you

Here's a fact-packed Bulletin that was revised *before* it was printed! Not the contents—which are still up to the minute—but the *quantity* of the printing order had to be greatly increased to meet the flood of requests that came about through our announcement of this new piece of product literature in recent issues of your favorite technical journals.

Paper Problems are now well in hand and copies of the new W-S Aluminum Extrusion Press Brochure will be in the mails starting *Monday, November 26th,* to those whose requests are already in. Thanks for waiting.

Want a Copy? Write today, if you haven't already done so, for this resumé of light metals extrusion equipment . . . methods, applications, machine capacities, time-saving set-up features and controls. It will help you assess the many advantages of in-plant extrusion—flexible, fast, economical production of your non-ferrous shapes . . . elimination of costly inventory and crippling shortages . . . stabilization of productive flow and labor force requirements.



9-L-35

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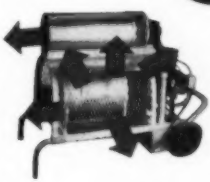
Mail coupon today for complete information about the Model RF and other Silent Glow Portable Heaters.



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6SHS1

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And as the men in uniform do their part, business men are working with intensified effort to make America stronger by providing the needs of our expanding semi-military economy.

American Locomotive, for example, turns out new medium tanks and other top priority equipment for the Army, Navy, Air Force and Atomic Energy Commission. And Alco also produces equipment for the increasing operations of essential railroad, oil, chemical and power industries.

Both lines of products strengthen our defense. It is this double-barrelled production of military and civilian essentials, typical of industry in general, which builds America's strength.

AMERICAN LOCOMOTIVE COMPANY

producing both industrial and defense essentials

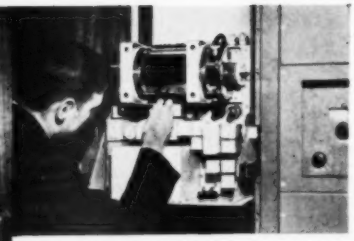
special gasketing that both seals and conducts high frequency currents. It makes an air-tight seal and yet prevents leakage of high frequencies between the bolt holes.

Cohrlastic conductive gasketing provides a continuous mounting and minimizes high frequency losses that affect radio operation.

It is widely used in aircraft (1) between the magnetos and their bases, (2) in the ignition harness, (3) in quick disconnect plugs and (4) wherever shielding is required.

Cohrlastic conductive gasketing is available in three different thicknesses—.016", .020" and .028" in rolls 8" wide and in the finished gaskets on a custom basis. Write for samples, prices and data sheets.

THE *Connecticut* HARD RUBBER COMPANY, 416 EAST STREET, NEW HAVEN, CONN.



Each crystal is enclosed in a cylindrical oven which holds the crystal temperature to within 1/100 of a degree.

At the A. T. & T. building at 195 Broadway, New York, passersby set watches by the world's most accurate public clock, which is controlled by the master standard.

Front of the new frequency-time standard at Bell Telephone Laboratories. In the rear there are 600 electron tubes and 25,000 soldered connections. Room temperature is maintained within two degrees.

The controlling quartz crystal vibrates in vacuum at 100,000 cycles per second. The standard is powered by storage batteries, with steam turbo-generator standing by, just in case of emergency.

A vibrating crystal keeps master time

Ever since Galileo watched a lamp swinging in the Cathedral of Pisa three centuries ago, steady vibration has provided the practical measure of time. In the 1920s Bell Laboratories physicists proved that the quartz crystal oscillators they had developed to control electrical vibration frequency in your telephone system could pace out time more accurately than ever before.

The Laboratories' latest master standard keeps an electric current vibrating at a frequency that varies only one part in a billion, keeping time to one ten-thousandth second a day.

Through secondary standards, a master oscillator governs the carrier frequencies of the Bell System's ship-to-shore, overseas and mobile radio-telephone services, the coaxial and *Radio Relay* systems which transmit hundreds of simultaneous conversations, or television. In the northeastern states, it keeps electric clocks on time through check signals supplied to electric light and power companies.

The new standard also provides an independent reference for time measurements made by the U. S. Naval Observatory and the National Bureau of Standards. Thus, world science benefits from a Laboratories development originally aimed at producing more and better telephone service.

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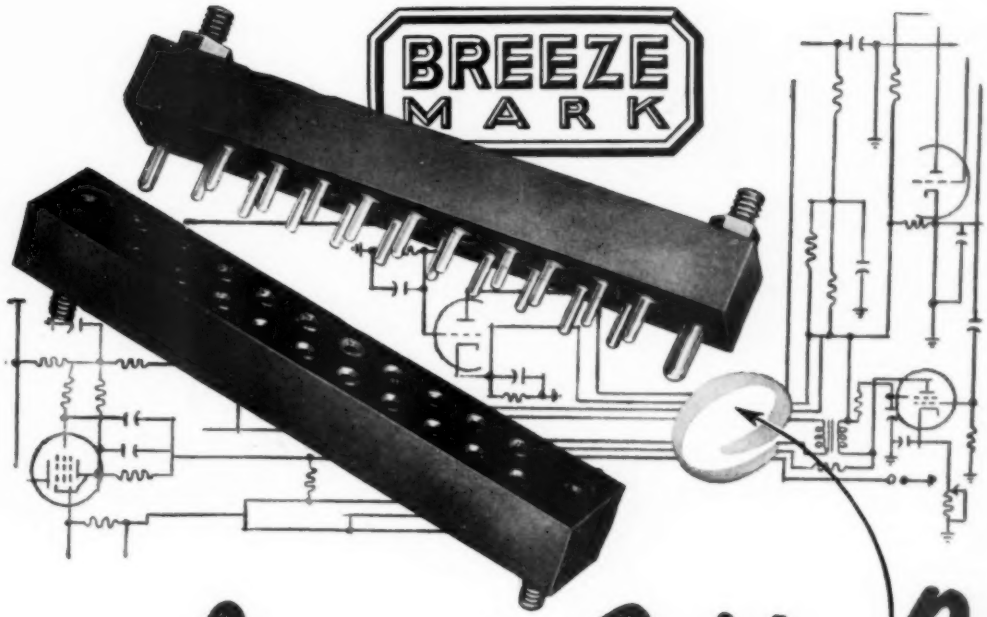
Improving telephone service for America provides careers for creative men in scientific and technical fields.



Connector Problem?

...We'll take it from HERE

Good ideas for electronic circuitry sometimes run afoul of connector problems. Maybe existing connector units won't hold air pressure gradients, won't stand the heat, aren't rugged enough for the job. Or maybe it's a question of altitude, or under-water application. But if you can sketch the circuit, we'll take it from there. We've engineered so many special connectors, solved so many "impossible" problems, that whatever the requirements are, we can usually provide the answer.

Lightweight actuators for any requirement.

Job engineered, welded-diaphragm bellows.

Flexible conduit and ignition assemblies.

Aero-Seal vibration-proof hose clamps.

WRITE TODAY for specific information, or send us your sketches. We'll forward recommendations promptly.

BREEZE
Special CONNECTORS

BREEZE CORPORATIONS, INC.

41 South Sixth Street Newark, New Jersey

Removable pins in Breeze connectors speed soldering, save time, trouble. Pins snap back into block.

How to cover a carriage

(and still keep the baby healthy!)

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That's why flawless Conmar zippers are approved for the M18's gun covers. Conmar zippers are rigidly tested, to meet the most exacting specifications of military and naval usage.

Conmar zippers are rust-proof, mildew-resistant, water repellent. No worry about slipping or jamming—they're constructed to take tremendous cross pull strain . . . yet work smoothly, easily.

There's a flawless Conmar zipper for every closure situation. When ordering zippers under Specifications QM-100-31, AN-229, or VF-106, call any of the Conmar offices listed below.

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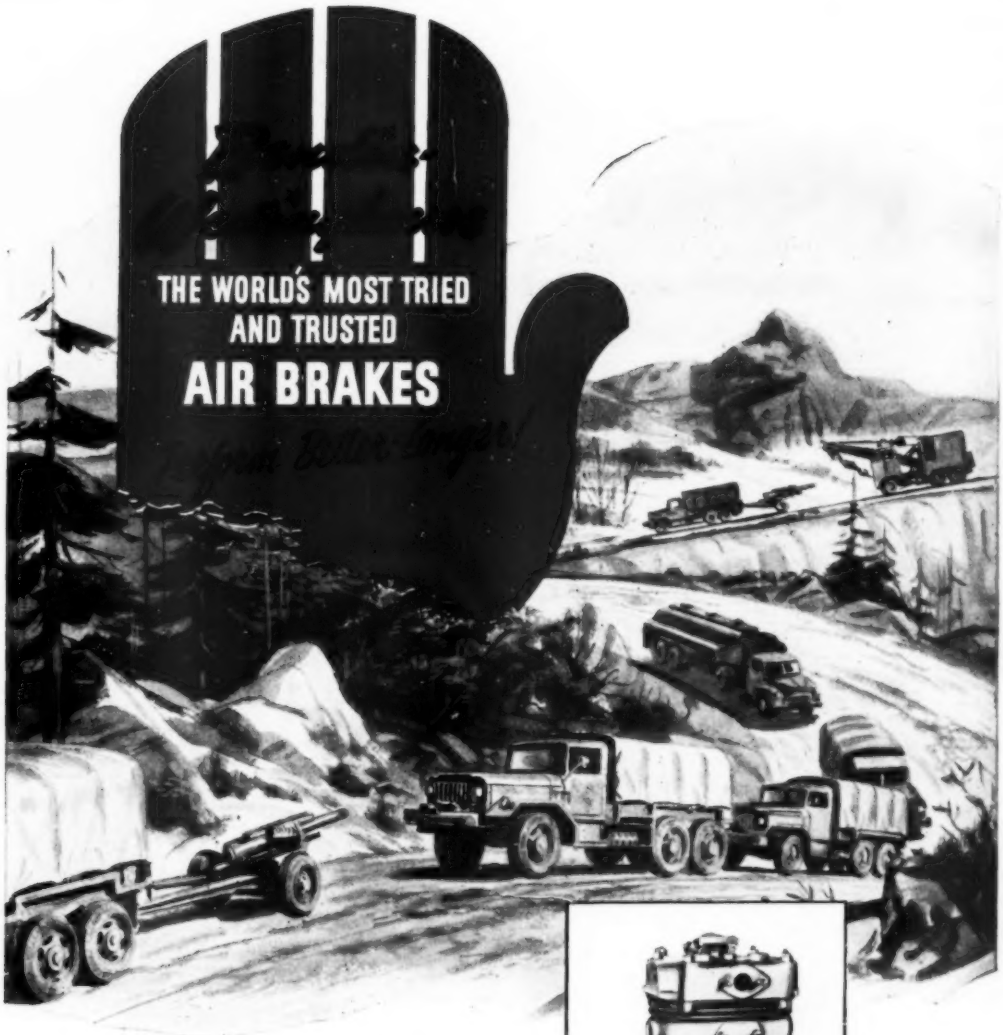
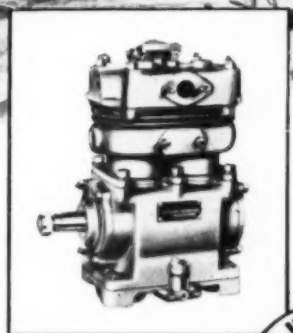


Over the treacherous mountain stretches of Korea . . . on the rugged, icy avenues of the arctic . . . through the steamy, swampy trails of the tropics, Bendix-Westinghouse Air Brakes have demonstrated a matchless ability for rugged, reliable performance on Ordnance vehicles in service the world over. That's because these mighty brakes are built for long life dependability and powerful performance while requiring little maintenance under even the most grueling operating conditions. The Bendix-Westinghouse compressor for example, designed on the same reciprocating piston principle as the standard truck engine, has proved its remarkable durability time after time by often *outlasting* the life of the vehicle itself. Take advantage of it—when you specify air brakes don't settle for a second choice—specify Bendix-Westinghouse, the world's most tried and trusted air brakes.



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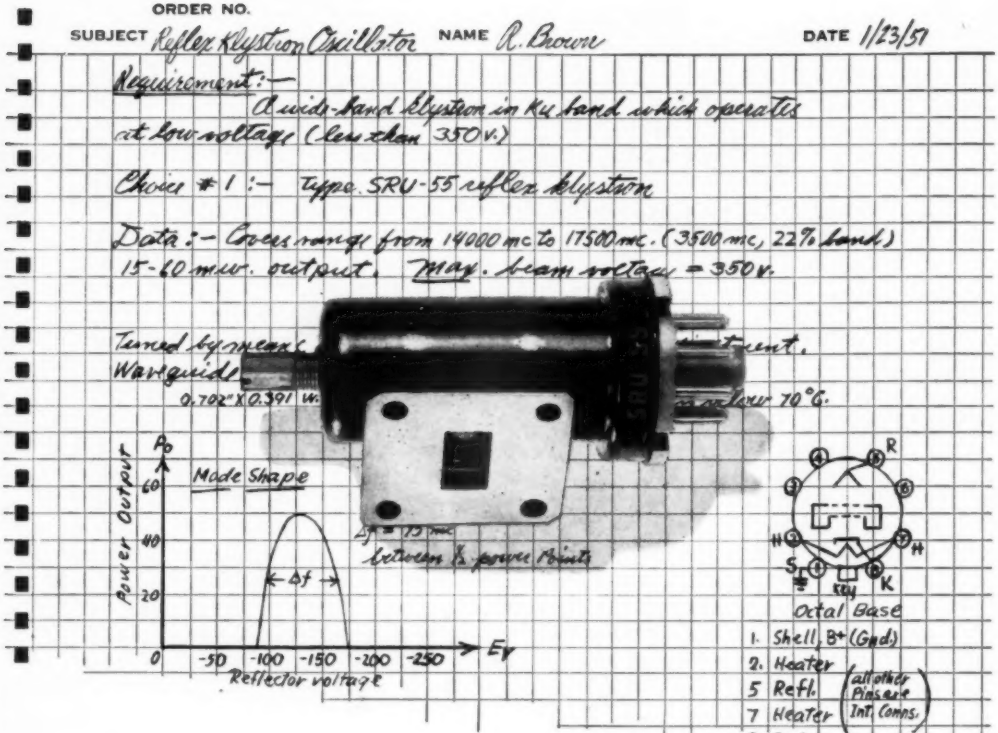
ORDER NO.
SUBJECT Reflex Klystron Oscillator
NAME R. Brown
DATE 1/23/51
Requirement:—
A wide-band klystron in Ku band which operates at low voltage (less than 350 v.)
Choice # 1 :— Type SRU-55 reflex klystron
Data :— Covers range from 14000 mc to 17500 mc. (3500 mc, 22% band.)
15-60 mw. output. Max. beam voltage = 350 v.
Tuned by means of
Waveguide
0.702" X 0.391 w.
Power Output
Mode Shape
Reflector voltage
Octal Base
1. Shell, B+ (Gnd)
2. Heater
5 Refl.
7 Heater
8 Cath.
(all other Pins are Int. Conns.)

. . . WIDE TUNING RANGE with LOW-VOLTAGE KLYSTRON

14,000 to 17,500 MC at 300 VOLTS

Type SRU-55 is a low-voltage, reflex klystron oscillator with radio frequency output of 15 to 60 milliwatts, operating over the frequency range of 14,000 to 17,500 mc. This Sperry tube can be used as a local oscillator for microwave receivers or as a bench oscillator in the measurements laboratory.

Operating at a frequency of 16,000 mc with a beam voltage of 300 volts, this tube provides 25 milliwatts of output power. Under these conditions the modulation sensitivity is approximately 1.3 megacycles per volt. The electronic tuning range measured between 3 db points is 75 megacycles per second.

Physical characteristics of Sperry Type SRU-55 are: weight, 3¼ oz. — height, 3 1/16" — mounting, standard octal 8-pin socket (in any position). The r-f connection is a standard UG-419/U fitting for 0.702" x 0.391" waveguide. Its cathode is of the oxide coated, unipotential type. For ambient temperatures below 70°C, only free convection cooling is required. The tuning adjustment on this tube is driven by a ¼" shaft containing a screwdriver slot.

For additional information on Type SRU-55 and other Sperry Klystrons, write our Special Electronics Department.

MODEL SRU-55	
GENERAL CHARACTERISTICS	
Freq. Range (mech. tuning)	*14,000-17,500 mc.*
Heater Voltage (ac or dc)	*6.3 v.*
Heater Current	*0.6 amp.*
MAXIMUM RATINGS	
Beam Voltage	*350 v.*
Beam Current	*35 ma.*
Reflector Voltage	*0 to —350 v.*
Heater-Cathode Voltage (peak)	*45 v.*

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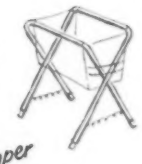
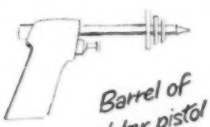
Bundyweld "Doodles"

to jog a designer's imagination



Frame of popular laundry hamper



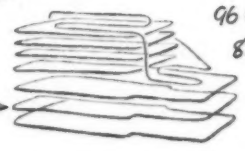
Barrel of Water pistol

Redesigning an old product? Developing a new one? With Bundyweld Tubing on the job, there's every chance for improved performance, lowered cost, smoother production, *or* some other practical plus.

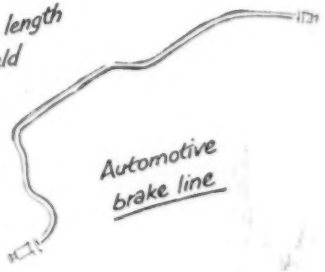
No other tubing has all the Bundyweld features. It's the only tubing double-walled from a single strip, with inside and outside beveled edges.

Too, you may profit from Bundy's famous fabrication skills. In working out tubing parts like those shown here, we may have found the answer to something baffling you. Or we can develop a new solution. Let us send you information on Bundyweld Tubing or Bundy services. ***Bundy Tubing Company, Detroit 14, Michigan.***

Coil for a Home Freezer



96 bends – 82' continuous length of Bundyweld



Automotive brake line

Bundyweld® Tubing

DOUBLE-WALLED FROM A SINGLE STRIP

Extra-strong
High fatigue limit
Leakproof
High bursting point
High thermal conductivity
Shock-resistant
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Takes plating
Takes plastic coating
Scale-free
Clean inside and out
No inside bead
Uniform I.D., O.D.

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Bundyweld starts as a single strip of copper-coated steel. Then it's . . .

continuously rolled twice around laterally into a tube of uniform thickness, and

passed through a furnace. Copper coating fuses with steel. Presto . . .

Bundyweld, double-walled and brazed through 360° of wall contact.

NOTE the exclusive patented Bundyweld beveled edges, which afford a smoother joint, absence of bead and less chance for any leakage.

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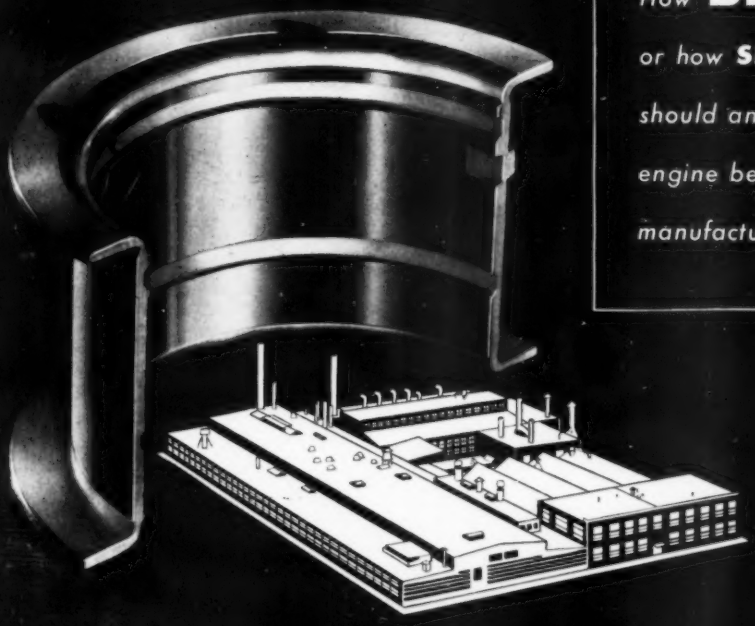


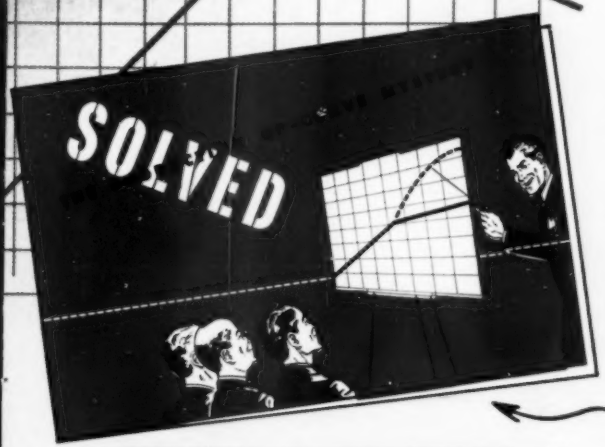
How **BIG**
or how **SMALL...**
should an
engine bearing
manufacturer be?

Our *BIGNESS* lies in our capacity to meet huge, mass-production requirements of our customers . . . our *SMALLNESS*—in the flexible use of our facilities to solve their most exacting problems of custom-production.

Because of this combination of abilities, we have been a supplier of original-equipment engine bearings to the leaders in the automotive industry for more than 25 years.

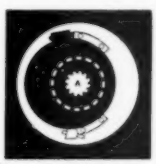
THE DETROIT ALUMINUM & BRASS CORPORATION
Detroit 11, Michigan

X Marks the Spot

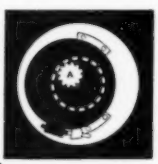


X marked the spot, high on the performance chart. That's where Company A's production curve should have gone.
Alas, it went *down* instead!
"Just what you'd expect," said the foreman. "This job calls for pretty near gage-block precision. To get that you have to sacrifice speed, don't you?"
Well—Company B had a similar job. Their production showed an up-curve.
How were they doing it?
Company A found the answer in the new booklet, "SOLVED: The Production Up-Curve Mystery." It tells how to do high precision metal-working at top production speeds . . .
Write for your copy today.

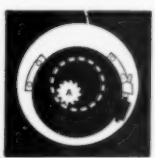
A PLANETARY FORM MILLER;
A PLANETARY THREAD MILLER; and
A COMBINATION FORM and THREAD MILLER
FOR BOTH INTERNAL AND EXTERNAL OPERATIONS



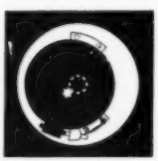
1. The work (dotted white circle) does not revolve. Cutter is revolved around work.



2. For internal thread and form-milling, cutter (A) moves out from center to contact with work.



3. Cutter moves in circle, completing cut; rapid reverse returns cutter to center.



4. For external milling cutter moves in to contact work; then moves around work.

PLAN-O-MILL

• REQUEST FORM •

PLAN-O-MILL CORPORATION
1517 E. Eight Mile Road
Hazel Park, Michigan

Please rush my copy of, "SOLVED: The Production Up-Curve Mystery"

Name_____ Title_____

Firm_____

Address_____

City_____ Zone_____ State_____

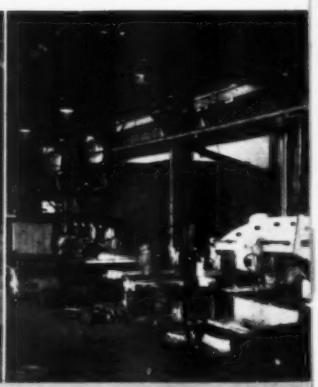
Prepared, Producing, Expediting

ARMOR PLATE

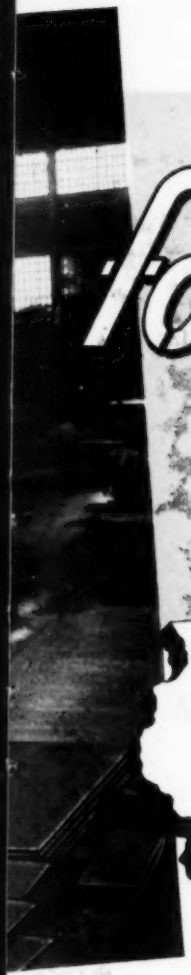
Typical stamping bay in one of the plants associated with the Standard Steel Spring Company armor plate program.

Edge preparation on heavy gauge armor plate.

Torch cutting a formed part.



Section of one of many machining bays—all equipped with the most modern machine tools.



for ORDNANCE

READY TO ASSEMBLE IN GAUGES ¼" TO 4" INCLUSIVE

DAYS CLOSER TO DEFENSE INDUSTRY

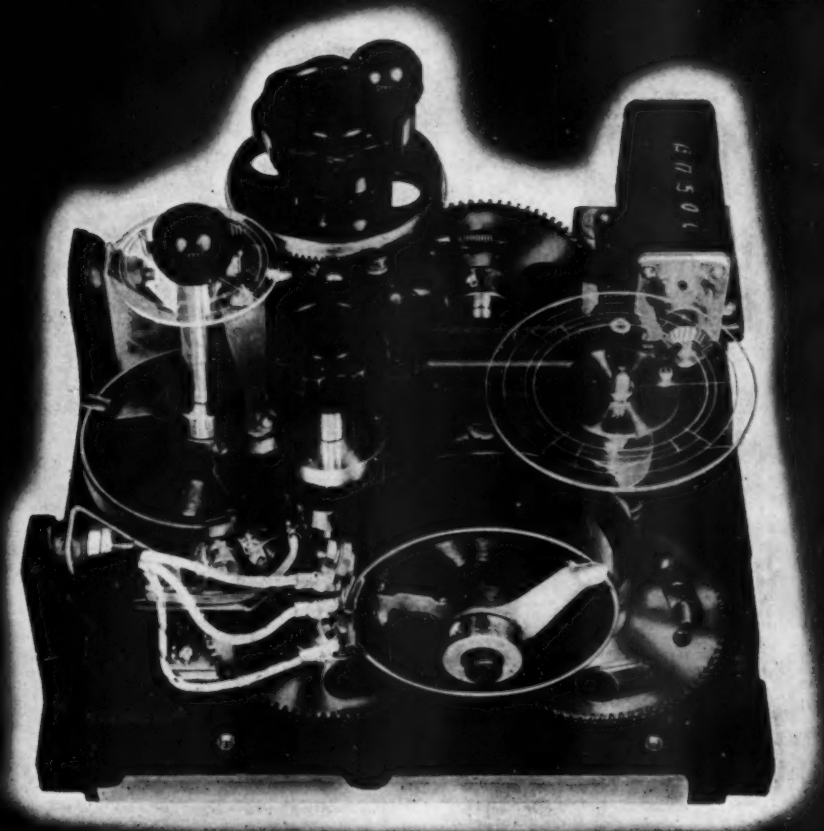
All defense production must meet *schedules* as well as *standards*. And nothing saves time like nearness to supplies. In developing its huge armor plate program Standard Steel Spring Company has carefully spotted its production facilities throughout the area where most defense contracts center. From these nineteen strategic locations shipments of flat or formed, fully machined parts can be economically made by overnight truck.

Time is on the side of those who use it best. You'll save time, save money and get every production assist by checking first with Standard Steel Spring Company on all your armor plate requirements. Write, wire or phone today.

Standard Steel Spring Company

ARMOR PLATE DIVISION • PENOBSCOT BLDG. • DETROIT, MICHIGAN

Precision Electro-Mechanical Equipment ...for All Industries



ATLAS OFFERS COMPLETE ENGINEERING, PRODUCTION AND ASSEMBLING FACILITIES

Take an intricate electro-mechanical product in the pilot stage . . . "iron out the kinks" . . . mass produce it . . . and assemble it with finest precision. That's the service Atlas "Precisioneers" offer American Industry. Extra hands to speed the output of vitally needed products that must be sub-contracted.

Atlas has an engineering and development staff capable of designing for mass production. Skilled craftsmen of the high speed machine tools, precision grinders, gear cutters and stamping presses. Experienced and exacting operators are on every assembly line to assure precision finished assemblies.

Atlas "Precisioneers" are master craftsmen of every step of the way in producing fine precision electro-mechanical assemblies — all services under one roof, under one responsibility. Whether you need a sub-contractor to mass produce assemblies for you or a source of supply for precision parts, Atlas offers you complete facilities. Speed your production — write for "Precisioneers For Industry."

ATLAS METAL STAMPING COMPANY
KENSINGTON AND CASTOR AVENUES
PHILADELPHIA 24, PENNA.

Have you heard about OAKITE'S great new pre-paint cleaner?

Here Is What Users Are Saying About Oakite Compound No. 33

Although Oakite Compound No. 33 is new to the metal industries, here are a few comments that show how first users like it. (Where the quote does not specify, the parts being cleaned are mentioned in brackets.)

MINNESOTA: "Oakite Compound No. 33 has everything I've used up to now beat a mile. The solvent action on . . . pin grease is remarkable." (auto body parts)

NEW YORK: "Paint appearance uniform; adhesion excellent; costs are down 50%." (radiant wall heating units)

CALIFORNIA: "This cleaner is what we've been looking for." (steel braces and aluminum sheets for truck bodies)

NEW JERSEY: "For removing silver soldering flux and fire scale from brass and copper, Oakite Compound No. 33 is just 100%." (radio antenna parts)

MARYLAND: ". . . perfect removal of welding flash, rust, oil . . ." (wire baskets)

NEW YORK: "This stuff is terrific! Removes grease and rust beautifully and leaves the surface fine for spraying." (sporting equipment)

OHIO: ". . . removes all grease, oil and rust in one operation. This will double painting production." (truck cabs)

NORTH CAROLINA: ". . . gives very nice paint adhesion." (kitchen cabinet parts)

MINNESOTA: "Rust removing is exceptional. No longer necessary to pickle the steel, then scrub . . ." (cabinets and parts for radio transmitters)

CALIFORNIA: "Oakite Compound No. 33 is saving several operations and much time." (small steel parts)

Technical Service Representatives in Principal Cities of U. S. & Canada

METAL finishers using Oakite Compound No. 33 say this new cleaning-phosphating material is just what they have been looking for: a metal-cleaner that combines three important operations into one:

1. **It removes rust** *at the same time that*
2. **It removes oil** *at the same time that*
3. **It prepares the metal for painting**

Oakite Compound No. 33 is great for removing rust, heat scale, tarnish, other oxides, oil, grease, smut, soldering and welding fluxes and identification inks.

Oakite Compound No. 33 develops excellent paint adhesion on steel, cast iron, aluminum sheet and aluminum castings.

For Use in Tanks or by Hand—Oakite Compound No. 33 is great for soak-cleaning metal parts of moderate size; and great for hand-swabbing on large parts like cabinets, doors, tables, tractors and truck cabs.

Often Avoids Pickling—Oakite Compound No. 33 saves money; frequently eliminating separate pickling operations on moderately rusty steel.

FREE For special bulletin on Oakite Compound No. 33, just drop us a note or mail the coupon.

SPECIALIZED INDUSTRIAL CLEANING

OAKITE

MATERIALS • METHODS • SERVICE

OAKITE PRODUCTS, INC.,
26 Thames Street, New York 6, N. Y.

Send me, without obligation, special bulletin A-9842 describing your new metal-cleaner, Oakite Compound No. 33.

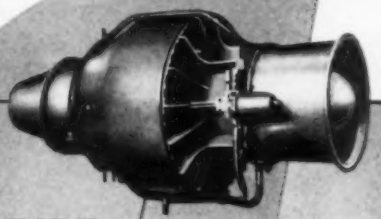
NAME.....

COMPANY.....

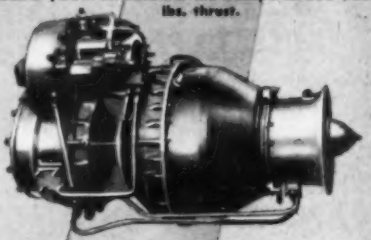
ADDRESS.....

It's no time to guess—about Quality
Cling to the tried and true, in Ball Bearings too. New Departure not only makes them of unsurpassed quality but builds in predictable performance under known conditions. Consult a New Departure engineer while your design is in the blueprint stage.
Nothing Rolls Like a Ball...
NEW DEPARTURE
BALL BEARINGS
NEW DEPARTURE • DIVISION OF GENERAL MOTORS • BRISTOL, CONNECTICUT
155

Announcing the CONTINENTAL-TURBOMECA Family of



JET POWER for target and trainer aircraft or as booster power on bombers and transports. 300-900 lbs. thrust.



SHAFT POWER especially suited for helicopters, utility aircraft, electric generators, etc. 225-400 h.p.

DUCTED FANS with wide potential utility as means of increasing speeds of small and medium-sized military and civilian utility aircraft. 300-800 lbs. thrust.

AIR COMPRESSOR supplying up to 2,000 cu. ft. of air per minute at 50 psi. Useful as starter for large aircraft turbines, as portable heater, or for operating pneumatic tools, particularly where lightness and compactness are required.

Continental Motors, pioneer in power for business and utility aircraft, announces another major pioneering step — its purchase of the exclusive United States manufacturing rights to a series of gas turbine models developed by the Societe Turbomeca, under sponsorship of the French Air Ministry.

The agreement with Turbomeca, climaxing months of technical work, testing and negotiation, in this country and in France, brings to the United States a far broader and more diversified line of turbines, in the 200-to-1,100 h.p. range, than has been available heretofore. Characteristics forecasting their widespread use include:

- **Small size and low weight in relation to power.**
- **Adaptability to all fuels, including those of low grade.**
- **Long life expectancy due to simplicity of design.**
- **Minimum use of critically scarce materials in their manufacture.**
- **A high degree of parts interchangeability among various models.**
- **Versatility. Useful power is delivered in any of four different ways.**

Continental Motors sees this Continental-Turbomeca family of engines as supplementing, rather than displacing, power plants of conventional design. The four basic models and their variations are expected to find wide acceptance, not only in military applications, but in many commercial fields as well.

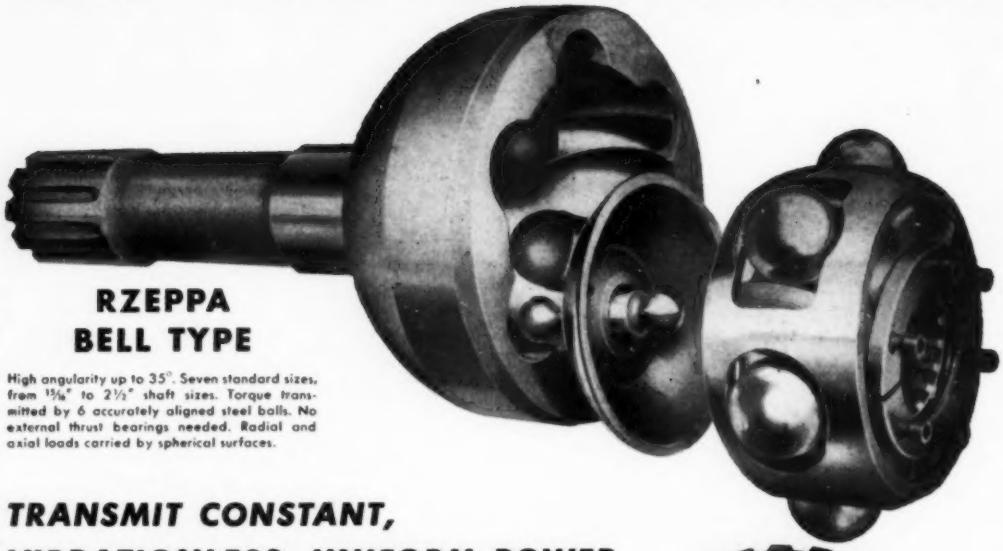
The Continental-Turbomeca family of gas turbines has been exhaustively tested in actual use. Plans for manufacture soon will be announced. Meanwhile, inquiries are welcomed. Please address Continental Motors Corporation, 1500 Algonquin Avenue, Detroit 14, Michigan — Attention Mr. Whitney Collins.

CONTINENTAL MOTORS · Powerful as the Nation · AMERICA'S STANDARD

Continental Motors Corporation

DETROIT AND MUSKEGON, MICHIGAN

CONSTANT VELOCITY
UNIVERSAL JOINTS



RZEPPA BELL TYPE

High angularity up to 35°. Seven standard sizes, from 15/16" to 2½" shaft sizes. Torque transmitted by 6 accurately aligned steel balls. No external thrust bearings needed. Radial and axial loads carried by spherical surfaces.

TRANSMIT CONSTANT, VIBRATIONLESS, UNIFORM POWER

These joints offer ordnance and industrial design engineers true constant velocity—free from the alternate pulsations that set up vibration even at slight angularity and destructive force as angularity increases.

The field records of over two million Rzeppa joints in the several divisions of our armed forces prove their dependability. The Rzeppa joint consists of an outer driving member and an inner driving member, with a ball cage between them—all assembled into a concentric unit. Each of the six balls transmits torque by free rolling action. No tools are required to assemble the various parts which position each other securely by interlocking. The result is a joint combining great strength, high capacity, constant velocity, compactness, low friction losses and the utmost in dependability.

You are invited to discuss any problems concerning universal joints with our engineering staff, whose long experience in many fields is available to manufacturers of ordnance and industrial products.

RZEPPA DISC TYPE

For low angle operation. Capable of 18° deflection. Sizes from 1⅞" O.D., taking ⅜" shaft and weighing 5 oz. to 10½" O.D., taking 3" shaft and weighing 62 lbs.

MANUFACTURED BY

The GEAR GRINDING MACHINE CO.

DETROIT 11, MICHIGAN

RZEPPA *Constant Velocity Universal Joints*

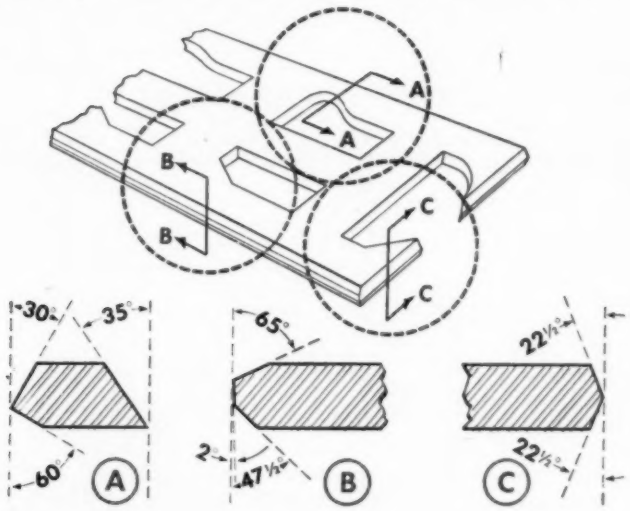
You asked for it . . . now Acetogen brings you

A Complete— STEEL FABRICATION SERVICE

— the only one of its kind

You undoubtedly have heard or read about the amazing Acetogen Process—the new way of flame-cutting armor plate and other steel to ±1/16 inch tolerance. *Now*, Acetogen offers you a *complete* steel fabrication service which employs this advanced flame-cutting method. You can have the toughest of fabricating jobs done for you *better, cheaper and faster!* Here's why:

The Acetogen Process of plate-edge preparation is so accurate, we can *flame-cut* steel to very close tolerances. *No longer is it necessary to grind an intricate bevel or radius.* Look at this example . . . a drawing of a finished plate which others must *grind* to required tolerances, but which we *flame-cut* to the same tolerances!



You can quickly see the tremendous savings effected by the Acetogen Process when applied to a complete fabricating job. We *don't* need expensive grinding machines or operators, we *don't* spend extra hours grinding plate edges to tolerances. We pass on *to you* a saving in both time and money!

And there are other advantages. Plate edges prepared by the Acetogen Process have a sufficiently low Brinell hardness to allow machining. Plates are ready for welding without *any* further preparation. Above all, *they are precise!*

A New, Fully-Equipped Plant

The modern Acetogen plant contains all the machine tools necessary to do a complete fabricating job (welding, forming, and sub-assembling) on armor plate, low-carbon and high-alloy steels, as well as on all other types of metals. It is operated by men thoroughly experienced in the working of these metals for both ordnance and aircraft applications.

Send us your drawings, sketches, or blueprints *now* for any fabricated work you have, and we will promptly quote price- and time-schedules. Our organization has full security clearance to contract for defense work through the Department of the Army, Philadelphia Ordnance Division. Let Acetogen take your fabricating problems off your hands! *Write today!* Acetogen Fabricators, Inc., Room 822, Commercial Trust Building, Philadelphia 2, Pa.

ACETOGEN FABRICATORS, INC.

Originators of precision flame-cutting

ROCKRITE TUBING

...the "heart" of the 3.5 rocket

THE PROBLEM: How to speed production of motor bodies for the critically important 3.5 rocket. **SOLUTION:** The use of Rockrite Tubing made of high quality 4140 steel for "the heart" of the job.

Here's why. Rockrite Tubing is sized by a distinctively different process to *much closer tolerances* than are practicable by any other method. Thus, motor bodies need *less machining*, and vitally needed metal is saved. Scrap is 64 per cent less than with ordinary cold-drawn tubing. Uniform walls are obtained more easily. Also, Rockrite Tubing has a superior surface finish. To guard against ruptures in the rocket launcher, heat-treated Rockrite Tubing is subjected to and stands up against internal pressures of 25,000 psi in hydrostatic tests.

The 3.5 rocket is another example of how Rockrite Tubing can save time and machining costs in the production of vital ordnance parts.

16-PAGE BULLETIN

tells story of Rockrite Tubing, and contains many other important advantages. Write for your free copy today.

ROCKRITE® TUBING

TR-126

TUBE REDUCING CORPORATION · WALLINGTON, NEW JERSEY

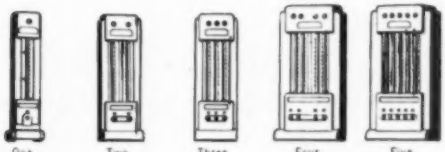
Checking bore diameters at 18 points.

Checking 27 crankshaft measurements.

Checking contour
of a turbine blade at 18 points.

Each individual measurement is indicated by the position of a float in its respective Precisionaire column.

The float positions form a characteristic pattern similar to a graph. It's actually a quality control chart. The inspector sees at one quick glance whether the work part can be passed or should be rejected, and for what dimensions. No eye strain, no close concentration, no figures to remember, no confusion of multiple dial faces with the "Airechart."



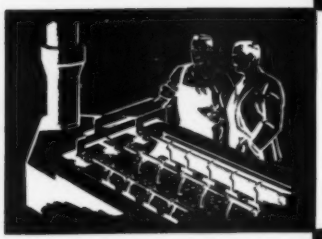
Standard Precisionaire column instruments are made with one, two, three, four or five columns. Special Precisionaires can be built to include from 6 to 30 or more columns depending on the number of dimensions to be checked.

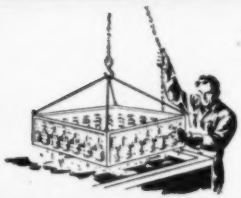
For complete details on simultaneous multiple measurements with the Precisionaire, call your local Sheffield representative, send prints to us or write for Bulletin CTP-491.

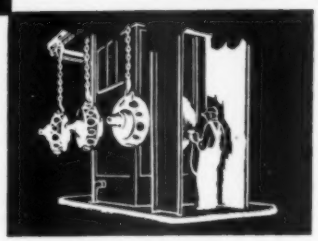
the *Sheffield* corporation

DAYTON 1, OHIO, U. S. A.

Want a hand with your... metal finishing problems?







Specialized help from United Chromium can save you time and expense in coating metals with metallic or organic finishes.

Problems involving finishing or protection of metals are United Chromium's specialty. With over 20 years successful service in the metal finishing field, U.C. electroplating and finishing engineers have an intimate knowledge of electroplated, organic, and chemically produced finishes. They can guide you to more efficient operations, show you how to get the results you want with speed and economy.

They can supply you with the right ordnance finish from the comprehensive, quality line of Unichrome Coatings for Metals. These are just a few widely used ones: Unichrome S.R.H.S. Chromium Solution which plates gun and airplane parts 20 to 80% faster than ordinary chromium . . . quick drying lustreless Unichrome Organic Coatings with outstanding durability . . . Unichrome Dips with which to meet chromate-treating specifications for zinc and cadmium . . . Anozinc for corrosion-protection of zinc-plated steel shell cases.

Answers to many other metal finishing requirements are as close as the nearest United Chromium office. Write or phone about your problem.

UNITED CHROMIUM, INCORPORATED 100 East 42nd St., New York 17, N. Y.

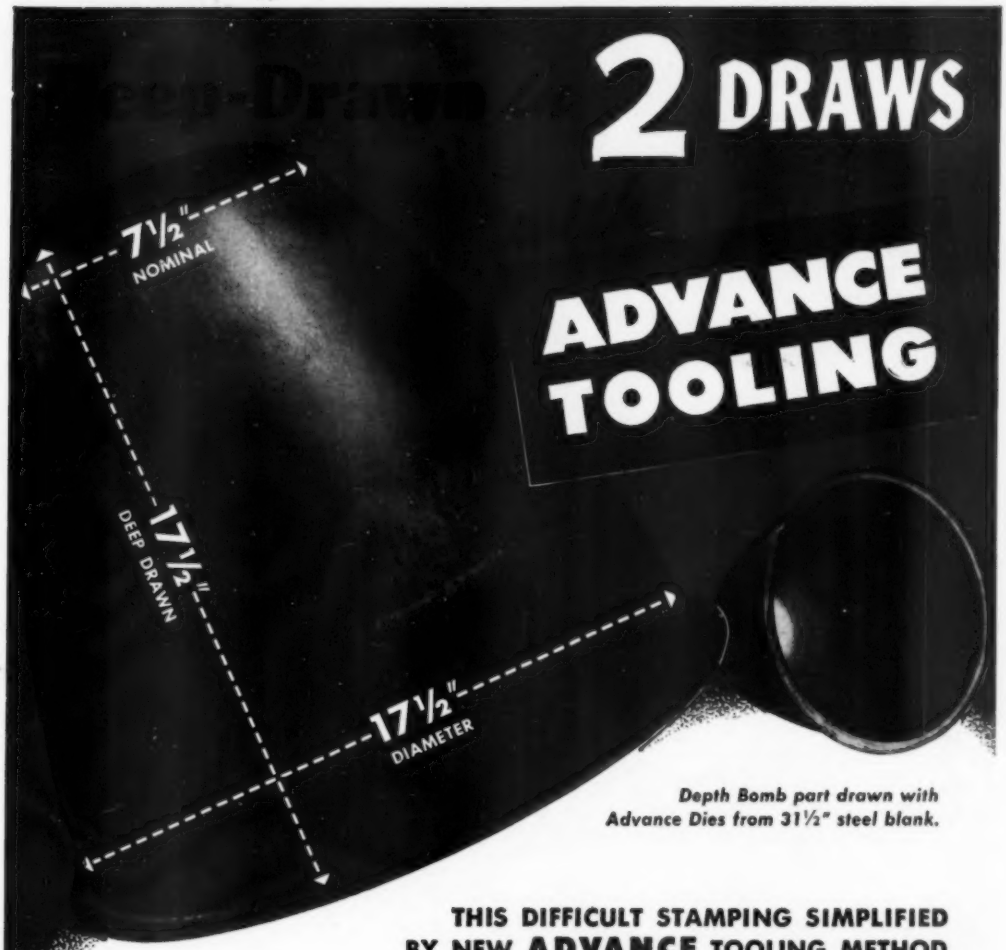
Waterbury 20, Conn.-Detroit 20, Mich.-Chicago 4, Ill.-Los Angeles 13, Calif.
In Canada: United Chromium Limited, Toronto, Ont.

UNICHROME Trade Mark

COATINGS for METALS

2 DRAWS

ADVANCE TOOLING

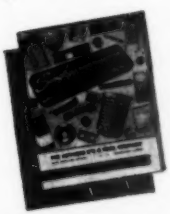


Depth Bomb part drawn with Advance Dies from 31½" steel blank.

THIS DIFFICULT STAMPING SIMPLIFIED BY NEW ADVANCE TOOLING METHOD

Here's another example of ADVANCE tooling ingenuity. The problem: This depth bomb tail piece deep-drawn to the dimensions shown above . . . in just two draws . . . from a 14-gauge steel blank. Similar pieces were formerly produced with five or six draws, or by butt-welding two halves.

Advance tooling techniques met the requirements — with dies that produced the part in two draws as specified. Advance can help you with your difficult drawing and stamping problems . . . and save you time and money in your processing operations. Our engineers and our completely equipped die plant are ready to serve you. Consult us — or write for complete information.



Write for Illustrated Descriptive Bulletin

ADVANCE DIE & TOOL CO.

6800 MADISON AVENUE — CLEVELAND 2, OHIO

PHONE: WOodbine)-9191

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WIREBOUND BOX PLANTS

are ready to serve you!

ALL FULLY INFORMED ON SPECIFICATIONS
AND REQUIREMENTS OF ALL GOVERNMENT BRANCHES

Strategically located to serve suppliers of all government services, Wirebound Box manufacturers are in excellent position to meet your shipping container needs. Parts boxes, equipment crates, over-packs and food containers are but a few of the multitude of uses for which Wirebound containers are adaptable. Wirebound manufacturers are informed, experienced and technically trained to design, produce and pre-test scientific containers for each use. Make it a point to consult your nearest Wirebound supplier or write for full information.

Wirebound Box Manufacturers Association
Room 1163, 327 South LaSalle Street, Chicago 4, Illinois

CYLINDER BOX

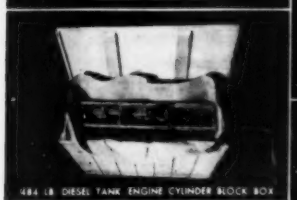
TYPICAL WIREBOUND OVERPACK

IMMERSION HEATER BOX

PROJECTILE BOX

FIELD RANGE CRATE

CHEMICAL BOMB BOX


484 LB. DIESEL TANK ENGINE CYLINDER BLOCK BOX

PRACTICE BOMB CRATE

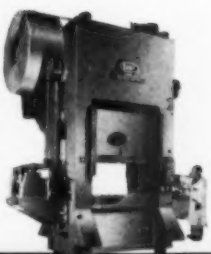
Wirebound
BOXES & CRATES
User's names on request

Danly helps management solve today's production problems

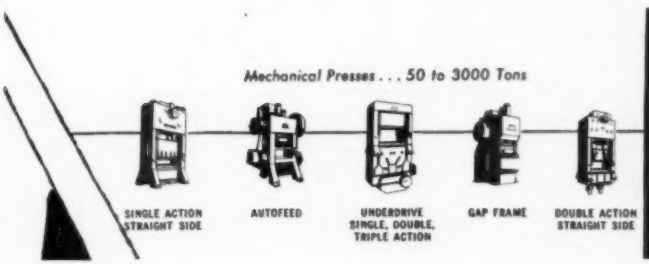
Selecting the right press for the stamping job you are planning involves consideration of many important factors including cost, capacity, production rate and maintenance requirements. Danly simplifies this decision because Danly Presses are engineered for maximum efficiency in individual applications. Costly compromises between standard press models and your actual needs are eliminated.

Danly Autofeed Presses like the one shown at right have tripled production where faster cycling was required. Other Danly Presses are designed to meet practically every possible production need. Call a Danly press engineer today . . . let him help solve your particular stamping problem.

DANLY MACHINE SPECIALTIES, INC.
2100 South Laramie Avenue, Chicago 50, Illinois



Mechanical Presses . . . 50 to 3000 Tons



DANLY

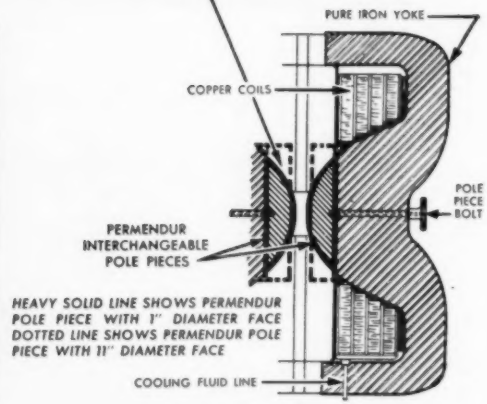
IT COSTS LESS TO RUN A DANLY PRESS!

PERMENDUR*

gives you

- ☆ High Magnetic Saturation
- ☆ High Permeability at very high Flux Densities
- ☆ High Value of Positive Magnetostriction
- ☆ Design Possibilities for Savings in Weight, Space and Materials

Typical use of Permendur in the ADL ELECTROMAGNET
(ARTHUR D. LITTLE, Inc.)


PURE IRON YOKE
COPPER COILS
POLE PIECE BOLT
PERMENDUR INTERCHANGEABLE POLE PIECES
HEAVY SOLID LINE SHOWS PERMENDUR POLE PIECE WITH 1" DIAMETER FACE
DOTTED LINE SHOWS PERMENDUR POLE PIECE WITH 11" DIAMETER FACE
COOLING FLUID LINE

Sectional Detail of Yoke Half

Permendur is available in Forgings, Castings, Hot-Rolled Bars and Plates to meet your design needs for form or shape. *Write for information*

*Manufactured under license arrangements with Western Electric Co.

WAD 3929

THE ARNOLD ENGINEERING COMPANY
SUBSIDIARY OF ALLEGHENY LUDLUM STEEL CORPORATION
General Office & Plant: Marengo, Illinois

Scaife research

The pressure vessels and deep-drawn shapes being made today in the Scaife factory are *better* because of scientific research in Scaife Laboratories. For example, the development of the new Scaife Dura-Lite LP-Gas Cylinder included a complete study of the deep-drawing process, using half-size parts made on the research department press shown above. This procedure, supplemented by complete metallurgical, physical, chemical and specialized studies, permits accurate evaluation of various materials, drawing methods and processing procedure. The result is a better, more serviceable product designed and made on sound engineering principles.

Here is the "big brother" of the press shown at the top of the page. Full-size cylinder-half has been formed in one stroke of the press (see right) and is being removed for processing and assembly.

Starting with a circular sheet of steel—

a cup is formed by a conventional drawing operation.

A continuation of this pressing operation turns the cup "inside out" without removing it from the dies,

completing—in a single stroke—the deep-drawn shape, which becomes a cylinder-half. Shown below is the complete cylinder, a standard container for liquefied petroleum gas. Similar Scaife cylinders are used for freon, acetylene and other materials.

SCAIFE COMPANY

OAKMONT (Pittsburgh District), PENNA.

Makers of Pressure Vessels for Air, Gases and Liquids

FOUNDED 1902

Operating at an all-time production peak
on prime defense contracts, but...

Ready, Willing and Able
to assume additional responsibilities
in the Rearmament Program

AERIAL PRODUCTS, INC.

ELKTON, MARYLAND

A decade of
Creative Leadership
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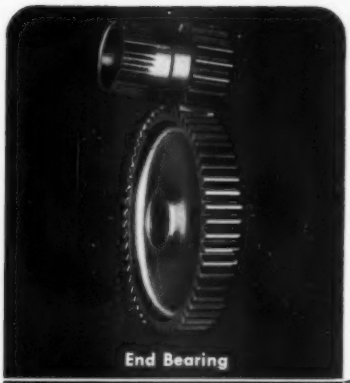
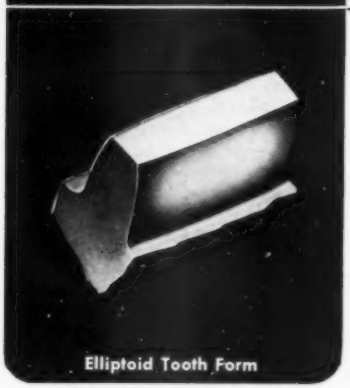
BASIC FACTS ON GEAR TOOTH CROWNING



End Bearing



Elliptoid Tooth Form

Q. ***Why are gear teeth given the Elliptoid tooth form or crowned?***

A. To PREVENT "end bearing" in service.

Q. ***What is "end bearing"?***

A. A concentration of load at the end of the tooth due to end contact between teeth rather than its distribution along the entire tooth face —the condition for which the tooth was designed.

Q. ***Why is "end bearing" objectionable?***

A. Because it imposes concentrated stresses beyond the fatigue strength of the material at the contact point which may lead to premature failure. It is also an important cause of noisy gear operation.

Q. ***What is gear tooth crowning?***

A. A calculated elliptical reduction in tooth thickness from the point of maximum crown (usually the center) toward both ends. Normally it amounts to .0003" per inch of face width per side, but this is optional depending on service conditions.

Q. ***Can "end bearing" be avoided by any other method?***

A. No. Because

1. It is practically impossible to assure perfect alignment under all conditions of loading due to unavoidable deflections in shafts, bearings and the mountings, all of which are elastic.

2. It is also impracticable to avoid all fire distortion in hardening gears which have been machined previously.

Q. ***How are gear teeth crowned?***

A. On Red Ring Shaving Machines.

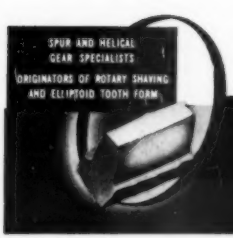
Q. ***Can the amount of crown be controlled accurately?***

A. Positively. Such a large number of leading automotive gear plants would not be using it otherwise.

Crowning is controlled on the Model GCI Shaving Machine by locking the cam which actuates the table movement at the desired point. Models GCU and GCV use formed cutters ground precisely to the amount of crown required. No variation is possible without changing cutters.

In a random check of 4000, 1" face gears the maximum variation in the amount of crown was within the specified tolerance of .0002".

Write for
BULLETIN S49-5
for a more detailed discussion of gear tooth crowning.



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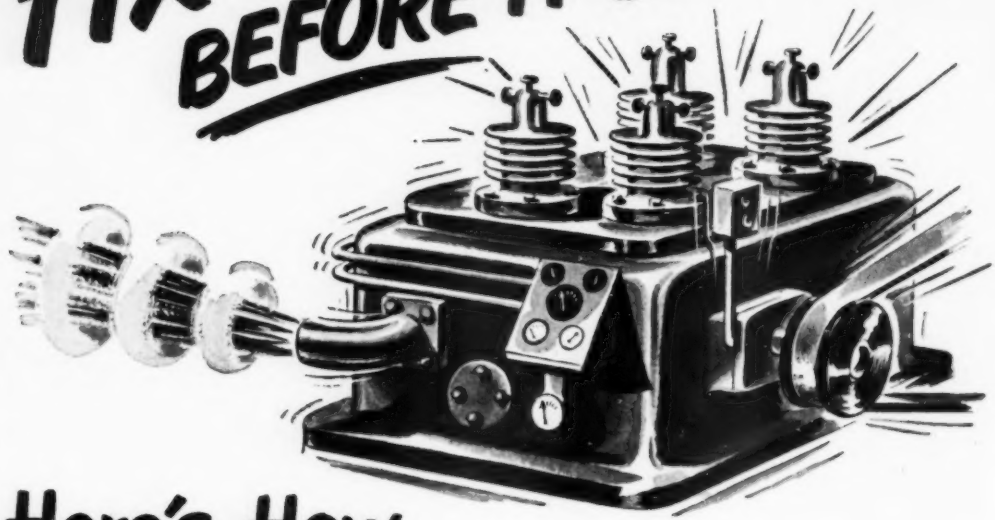

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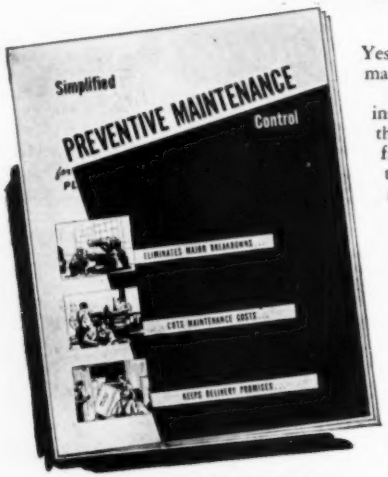

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When the maintenance job is complete, the maintenance man checks off what he did and the card is returned to its place, *automatically* signaling job completion. Then, the Kardex signals are advanced to the next date specified. Details are posted on the maintenance card from the job card, providing a continuing, *permanent* record of maintenance activity.

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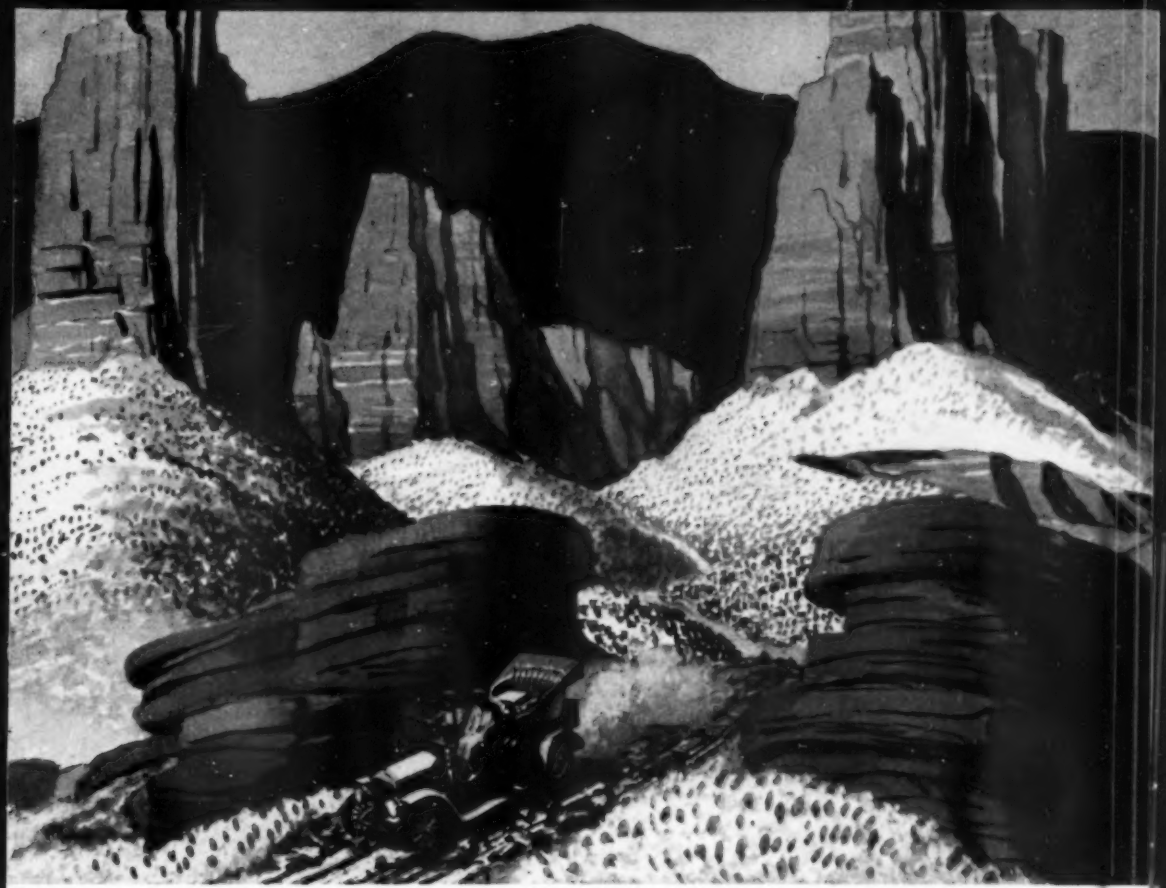

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The matrix of nickel alloyed irons closely resembles the pearlitic matrix found in high carbon steels, whereas the matrix of ordinary plain iron resembles that found in low carbon steels. Compositions of nickel alloy irons can be adjusted to reduce "chill" in thin sections without risk of forming "spongy" regions in heavy sections. This promotes uniform strength, improved machinability, pressure tightness and wear resistance.

Hardness in nickel cast irons results from improvement of the matrix. Chilled areas and hard carbides, which impair machinability, are obviated. Nickel improves response to heat treating. In fact, use of nickel alone or with other alloying elements plays an important part in meeting a variety of requirements.

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Strength

Tensile and transverse strengths of castings are greatly increased by the addition of nickel to cast irons of properly adjusted base mixture. The ratio of compressive strength to tensile strength is retained. Greater uniformity of strength in thick and thin sections is achieved.

Elasticity

The elastic modulus increases with strength. In this respect nickel-containing irons of the high strength type possess good stiffness and do not deform permanently under loads that would be damaging to irons of lower elastic modulus.

Damping Capacity

The damping capacity inherent in gray cast iron is not impaired by the presence of nickel.

Wear Resistance

The uniformly pearlitic matrix of nickel cast irons appreciably improves wear resistance. The uniformly fine graphite flake distribution, achieved in suitably processed irons *without formation of a poor wearing dendritic condition*, affords optimum resistance to wear and galling.

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Characterized by dense grain structure and fine dispersion of graphite throughout, nickel alloy irons are close-grained and offer an extraordinary degree of pressure tightness under high hydrostatic pressures, without sacrificing machinability.

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Heavy machinery frames and *beds* are typical of cast parts that benefit from the rigidity and good damping capacity of nickel cast irons. *Cylinder* and *pump liners, gears, dies, machine tool ways, saddles* and *tables* exemplify parts produced in nickel irons to assure greatly increased strength and wear resistance. And nickel alloyed iron is used for *heavy duty brake drums* to resist heat checking, thermal shock, wear and galling. The nickel cast irons are readily heat treated, and respond particularly well to flame and induction hardening.

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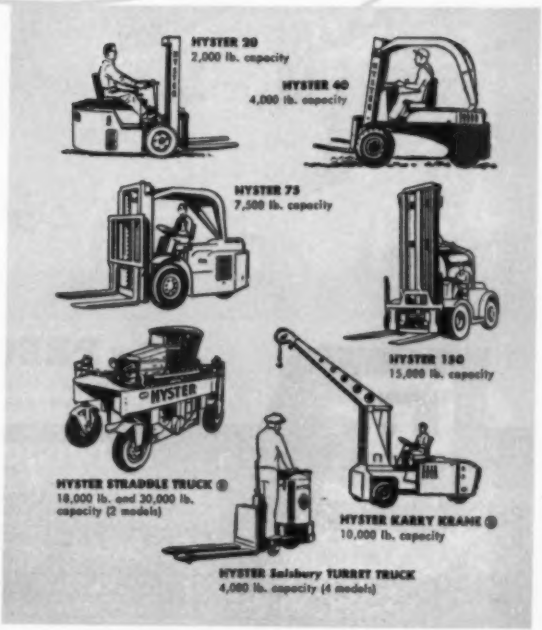

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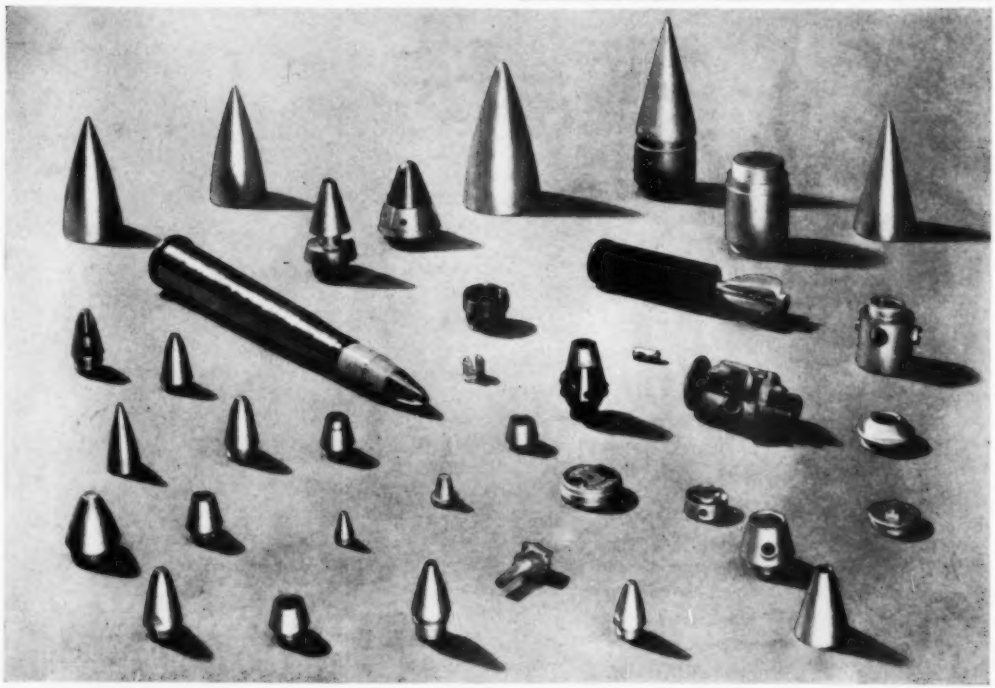

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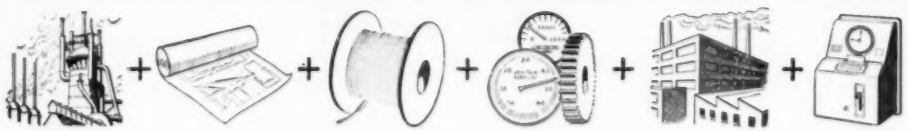

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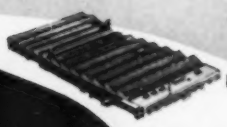

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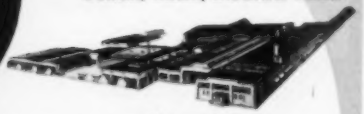

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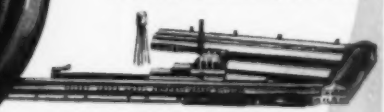

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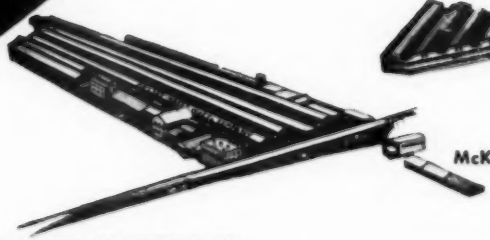

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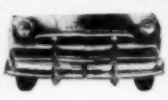

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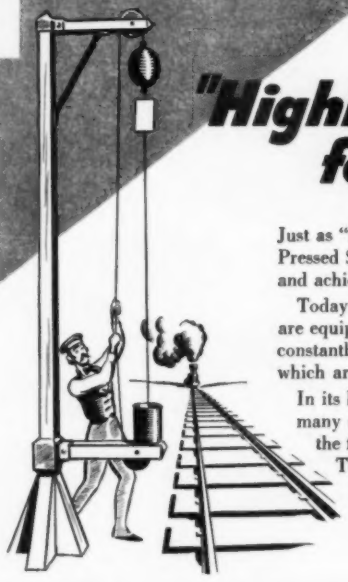

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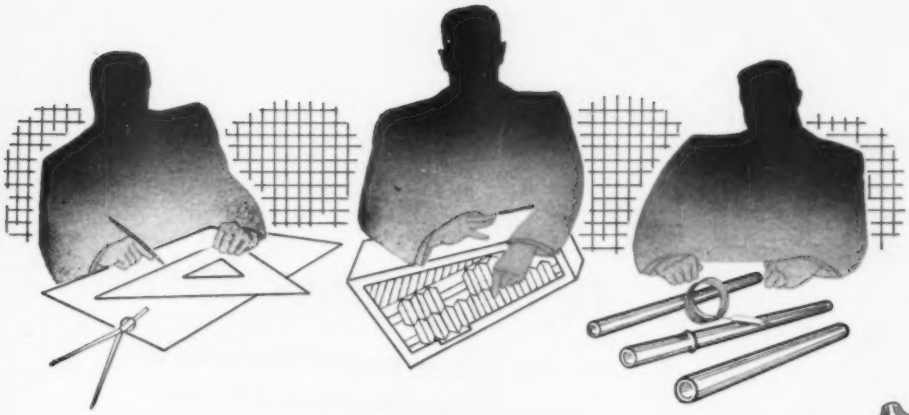

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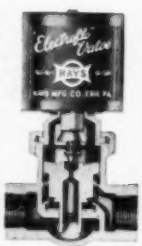
Here's another of the specialized products designed and produced by HAYS . . . the "ELECTROFLO" Valve.

The "ELECTROFLO" combines the power of electricity with flow pressure in a valve that sets new standards of performance at low cost. Delivers maximum flow . . . handles water or air . . . readily adapted to all types of control devices.



HAYS MANUFACTURING COMPANY
General Offices, Machining, Fabricating and Assembly Plant
803 West 12th Street, ERIE, PA.
Foundries: Erie, Pa., and Albion, Pa.

HAYS

THE INDUSTRY'S FINEST POWER BRAKING SYSTEMS

on Highways Everywhere!

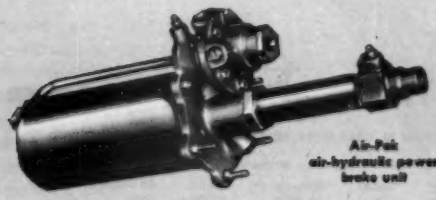
Regardless of the size of vehicle or whether the preference is for vacuum or air, the trucking industry has come to look to Bendix Products as the one source uniquely qualified to meet every power braking need.

Hydrovac, the world's most widely used power brake, is the undisputed leader in the vacuum-hydraulic field. And Air-Pak is recognized as foremost in the field of air-hydraulic power braking units.

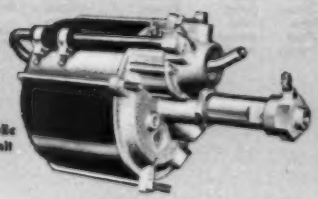
Products of twenty-five years of practical braking experience, these outstanding power braking systems offer faster, more positive and better controlled braking. And in *both* the vacuum and the air actuated units, brakes can be applied instantly by foot power *alone*—a constant safety factor of tremendous importance.

That's why on highways everywhere the preference is for Bendix® Hydrovac® or Bendix Air-Pak, the Industry's Finest Power Braking Systems.

®REG. U. S. PAT. OFF.



Air-Pak air-hydraulic power brake unit



Hydrovac vacuum-hydraulic power brake unit

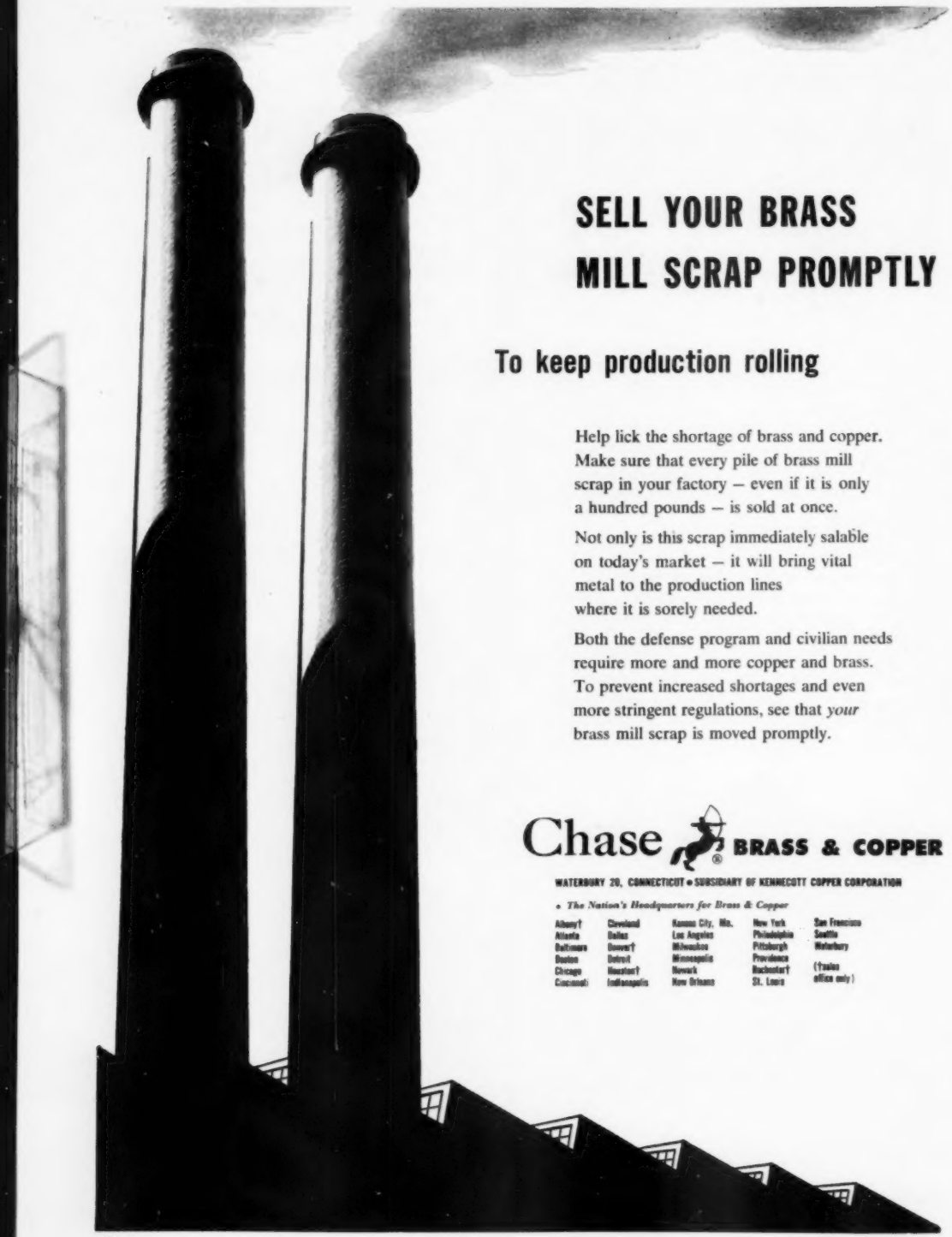
BRAKING HEADQUARTERS for the AUTOMOTIVE INDUSTRY

BENDIX · PRODUCTS DIVISION · **SOUTH BEND**

Export Sales: Bendix International Division, 72 Fifth Ave., New York 11, N.Y. • Canadian Sales: Bendix-Eclipse of Canada, Ltd., Windsor, Ontario, Canada

Bendix Aviation Corporation

Bendix Products Division



SELL YOUR BRASS MILL SCRAP PROMPTLY

To keep production rolling

Help lick the shortage of brass and copper. Make sure that every pile of brass mill scrap in your factory – even if it is only a hundred pounds – is sold at once.

Not only is this scrap immediately salable on today's market – it will bring vital metal to the production lines where it is sorely needed.

Both the defense program and civilian needs require more and more copper and brass. To prevent increased shortages and even more stringent regulations, see that *your* brass mill scrap is moved promptly.

Chase BRASS & COPPER

WATERBURY 20, CONNECTICUT • SUBSIDIARY OF KENNECOTT COPPER CORPORATION

• *The Nation's Headquarters for Brass & Copper*

Albany†	Cleveland	Kansas City, Mo.	New York	San Francisco
Atlanta	Dallas	Los Angeles	Philadelphia	Seattle
Baltimore	Dorvert†	Milwaukee	Pittsburgh	Waterbury
Boston	Detroit	Minneapolis	Providence	
Chicago	Houston†	Newark	Rochester†	(†sales office only)
Cincinnati	Indianapolis	New Orleans	St. Louis	

DO YOU KNOW THE LAW-KNOX STORY?

Blaw-Knox occupies a unique position in industry. The scope of its products and services—some of which are shown here—is broad and comprehensive, while its specialized engineering knowledge is practically inexhaustible. The booklet, "Welcome to Blaw-Knox," tells our story pictorially. May we send you a copy?

BASIC PRODUCTS FOR INDUSTRY

- ROLLS FOR STEEL & NON-FERROUS MILLS
- ROLLING MILLS & AUXILIARY MACHINERY
- OPEN STEEL FLOORING
- PREFABRICATED PIPING SYSTEMS
- OPEN HEARTH FURNACE EQUIPMENT
- FIRE PROTECTION EQUIPMENT
- CHEMICAL & FOOD PROCESSING EQUIPMENT
- CONCRETE & ASPHALT ROAD PAVING MACHINERY
- COMPLETE CHEMICAL & INDUSTRIAL PLANTS
- STANDARD STEEL BUILDINGS
- RADIO, TELEVISION & TRANSMISSION TOWERS
- HEAVY STEEL CASTINGS
- HEAT & CORROSION RESISTING ALLOY CASTINGS
- STEEL FORMS FOR CONCRETE CONSTRUCTION
- CONTRACTORS EQUIPMENT
- CLAMSHELL BUCKETS
- ENGINEERING SERVICE

RECENT CATALOGS AND BULLETINS detailing practically all Blaw-Knox products are available, and any literature you request will be forwarded by return mail.

OPERATING AND SALES DIVISIONS—BLAW-KNOX • BLAW-KNOX SPRINKLER* • BUFLOVAK EQUIPMENT • BUFLOVAK MIDWEST CO. • CHEMICAL PLANTS* • THE FOOTE COMPANY, INC.** • LEWIS FOUNDRY & MACHINE • NATIONAL ALLOY STEEL • PITTSBURGH ROLLS • POWER PIPING* • UNION STEEL CASTINGS

*Operates as a division of Blaw-Knox Construction Company

**Subsidiary of Blaw-Knox Company

*Awarded seven "E's" during World War II

FLUID HEAT'S ENGINEERS

can solve these problems for you!

PERHAPS the answer to *your* heating problem lies in one of Fluid Heat's production units . . . or in a slightly modified model. On the other hand, your requirements may necessitate a complete new design and development project. In either case, Anchor's experience is at your command.

For over twenty-five years the Fluid Heat Division of Anchor Post Products, Inc., has been designing and building heating equipment . . . heating equipment to fill particular requirements . . . heating equipment designed and developed from start to finish in Anchor's own laboratories.

Anchor's engineering know-how has produced compact, independently operated heaters for personnel heating that faithfully put forth from 15,000 to 100,000 B.T.U.'s per hour on a minimum of gasoline, kerosene, diesel oil or fuel oil. This same know-how has produced the famous Fluid Heat Coolant Heater that gives instant starts under the most trying atmospheric conditions and temperatures down to 65° below zero.

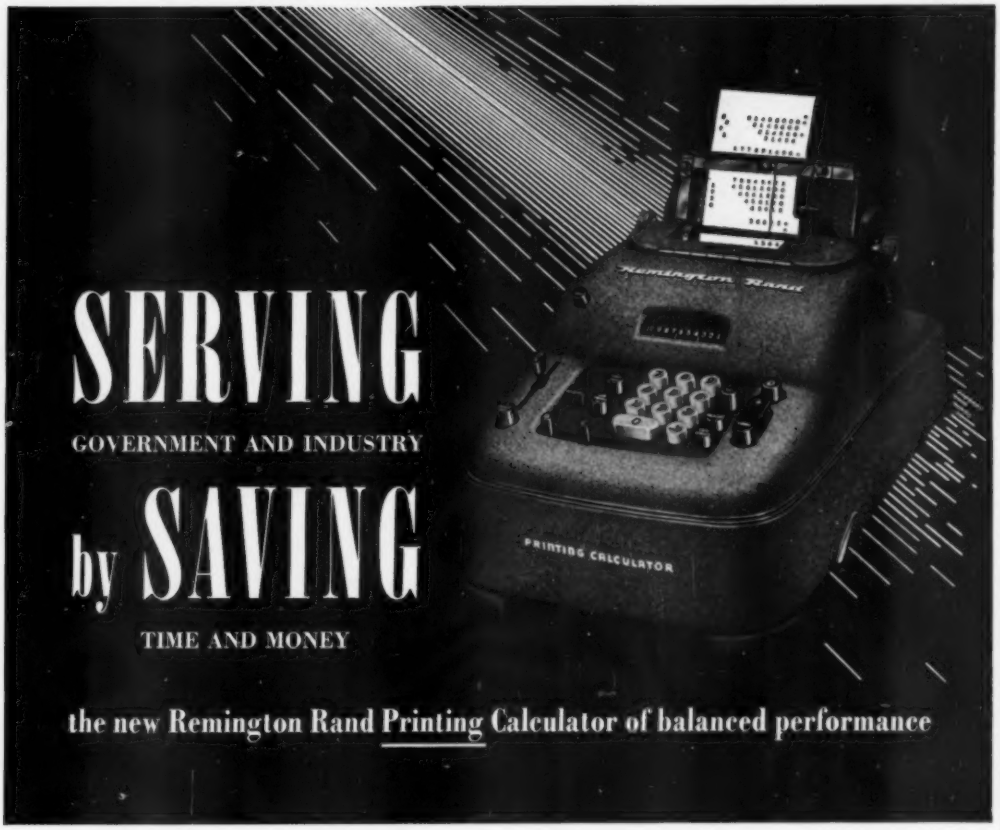
Currently in production, for example, is heating equipment aimed to keep America's mobile military equipment and personnel ready for action regardless of weather . . . heating equipment that meets all the rugged requirements of the Armed Forces' latest specifications.

To find out how Anchor can help you solve your heating problems, write or phone the Fluid Heat Division, Engineering and Design Section. Specifications, data, and above all, *experience*, are yours for the asking!

fluid heat
PRODUCTS

DIVISION OF ANCHOR POST PRODUCTS, INC.
6805 Eastern Ave., Baltimore 24, Md.
Phone BRoadway 1500

DESIGNERS AND MANUFACTURERS OF Space Heating Equipment • Fluid Heat Marine Heaters • Cargo Heaters • Coolant Preheaters • Automatic Oil Heaters • Rotary Burners • Boiler Burner Units • Air Conditioning Heaters • Pressure Burners



IN THE RACE to full preparedness, government and industry stand in far greater need for new and better ways to cope with the tremendous strain of shortages—new regulations—production deadlines—all the problems that must be faced during critical times like these.

To save precious hours that add up to days and weeks, the Remington Rand *Printing* Calculator stands ready to cut your figure production time to an absolute minimum. It's truly the modern machine for modern business—giving you short-cut multiplication—automatic division—"quick as a flash" addition and subtraction—plus *printed proof of figure accuracy.* The compact 10-key keyboard cuts training time—speeds operation. And remember, you get all these features on *one machine*—that's real double duty for double value.

Contact your Remington Rand Sales Representative—or send us the coupon below—for complete, detailed information on how the *Printing* Calculator can serve by saving—for you.

Remington Rand INC.

Business Machines and Supplies Division
Room 2397, 315 Fourth Avenue, New York 10, N. Y.

Please send FREE *booklet showing how I can save time and money with the* Printing *Calculator.*

NAME_____ TITLE_____

COMPANY_____

ADDRESS_____

CITY_____ ZONE____ STATE_____

IN THE FRIGID ARCTIC... ...ON THE HOT DESERT SANDS

ANSUL ALL-TEMPERATURE FIRE EXTINGUISHING EQUIPMENT IS YOUR *BEST* PROTECTION

FOR FLAMMABLE LIQUID, GAS AND ELECTRICAL FIRES

Ansul Low Temperature Dry Chemical Fire Extinguishers, Models LT-4-A and LT-20-A, have been tested and approved for operation at 65° F. below zero. These same extinguishers will withstand prolonged exposure to temperatures ranging up to +160° F. They are recommended for use where extreme temperature conditions prevail . . . where other types of fire extinguishers may be inoperative or ineffective.

MODEL LT-4-A ABOVE, CENTER MODEL LT-20-A

Ansul Wheeled and Stationary Extinguishers can be provided with special hose to allow operation at temperatures lower than -40° F.

For flammable liquid fires, Ansul Dry Chemical Fire Extinguishers have the greatest fire-killing ratings ever attained by hand and wheeled portable fire extinguishers . . . Based on tests by nationally recognized approval agencies.

NOTE THESE IMPORTANT ANSUL FEATURES . . .

- Patented nozzle provides most effective stream pattern.
- Easy, on-the-spot recharging. (No tools needed.)
- Low maintenance costs — no annual recharge necessary.
- Water-tight, corrosion-resistant construction.
- Safe to use on electrical fires.
- ANSUL *"PLUS-FIFTY"*® Dry Chemical is non-toxic, non-abrasive, non-corrosive.

Get the facts. See comparative effectiveness ratings for various types of approved fire extinguishers. Write for File No. 694. You will receive complete information and other valuable data.

ANSUL CHEMICAL COMPANY
Fire Extinguisher Division
MARINETTE • WISCONSIN

DISTRIBUTORS IN ALL PRINCIPAL CITIES IN THE U. S. A., CANADA AND OTHER COUNTRIES

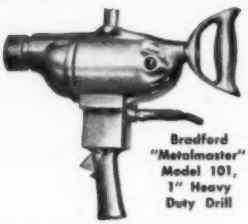
BRADFORD TOOLS

• DO A BETTER JOB
• ARE A BETTER BUY

Bradford 5" and 6" Aerial Grinder

GRIND, BRUSH, POLISH all classes of work, from ornamental iron to heavy castings and "I" beams. This Bradford tool has excellent balance, makes possible fast, accurate work. Powerful motors develop ½ h.p. on 5" and 1 h.p. on 6"; has no-load speed of 4800 r.p.m. Ball bearing construction. Equipped with 5" and 6" general purpose wheels. Length, 25"; weight, 17 lbs.

FOR MAN-SIZE DRILLING JOBS



Bradford "Metalmaster" Model 101, 1" Heavy Duty Drill

Wherever you need extra drilling capacity —in the shop or out on the job—this rugged Bradford heavy duty drill will meet your requirements. With power far beyond rated capacity, this Bradford drills 1" in steel; 3" in hardwood. Does reaming to ¾". Ball bearing construction, with bearing seats precision bored. Pipe and swivel spade handles are detachable. Internal collet, No. 3 Morse Taper. Standard motors are 110 and 220 volt AC/DC. Whatever your drilling job there's a Bradford Drill in the *right* power rating, size and housing type to fit your needs exactly —from ¼" to full 1" capacity.

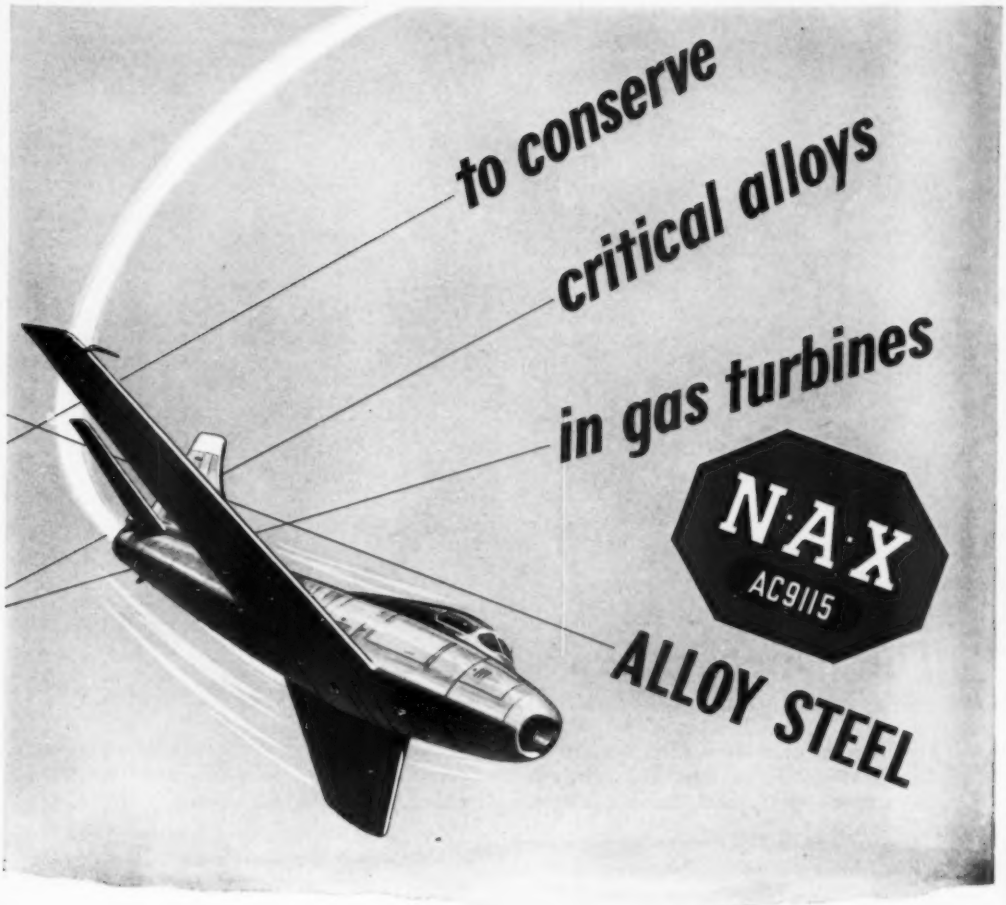
BRADFORD "Metalmaster" LATHES

Geared Head Engine and Tool Room Lathes, 14", 16", 18" actual swing. Famous for their precision and rugged dependability.

See your tool supplier for complete specifications on Bradford Tools designed to your production requirements. Write for descriptive literature.

PORTABLE ELECTRIC DRILLS • SAWS • SANDERS • POLISHERS • BENCH GRINDERS • PEDESTAL GRINDERS AND BUFFERS

THE BRADFORD MACHINE TOOL CO.
655 Evans Street Cincinnati, Ohio
Precision Since 1840



N-A-X AC9115 ALLOY STEEL offers a means of reducing the use of critical alloy steels of the "stainless" type in gas turbine and similar applications. In specific cases it has replaced over half the amount of strategic material originally required, with no sacrifice of quality.

SCRAP STEEL

N-A-X AC9115 ALLOY STEEL has high strength and toughness values at temperatures ranging from −70° F. to +1,000° F. It can be readily cold formed into the most difficult shapes; its response to welding by any process is excellent. It must, however, be suitably coated for protection against cold or hot corrosion.

Investigate the outstanding properties and characteristics of N-A-X AC9115 ALLOY STEEL and, through its use, conserve the critical material so necessary to our nation.

GREAT LAKES STEEL CORPORATION

N-A-X Alloy Division • Ecorse, Detroit 29, Michigan

NATIONAL STEEL CORPORATION

These men have a word for it

Army, Navy, Air Force, Marine Corps, the Coast Guard —all specialists, all working together on the biggest job there is. What makes it possible? The word is *integration.*

Integration—the unified control of diverse activities. It's the secret of successful combat operations. It's also a guiding principle of the Daystrom organization.

Daystrom subsidiaries and divisions manufacture a lot of different products, because Daystrom believes that product diversification makes for a stronger and more stable business.

And to keep all its units running smoothly and efficiently, Daystrom relies on *integration* through its own joint chiefs of staff—men of wide experience who know how to work together effectively. It's a system that gets the job done right, on a battlefield or in a factory.

The Daystrom family:

AMERICAN TYPE FOUNDERS, INC., Elizabeth, N. J. and Mount Vernon, N. Y. Letterpress, offset and gravure printing presses, foundry type and other graphic arts equipment.

DAYSTROM INSTRUMENT DIVISION, Plainfield, N. J. and Archbald, Pa. Manufacturer of defense materials.

DAYSTROM LAMINATES, INC., Alma, N. C. Producer of hard plywoods.

DAYSTROM FURNITURE, Eastern Division, at Olean and Friendship, N. Y. Produces chromed tubular steel and wood dinette sets.

DAYSTROM FURNITURE, Western Division, at Fullerton and Anaheim, Calif. Chromed tubular steel and wood dinette sets.

DAYSTROM ELECTRIC CORPORATION, Poughkeepsie, N. Y. Manufactures sound recorders and electronic instruments.

DAYSTROM, INCORPORATED

(Formerly ATF Incorporated) ELIZABETH, N. J.

This advertisement is set in ATF type faces: Garamond Old Style, Goudy Bold, Palmer, and Bernhard Modern Bold

Big yardage -fast haul speeds-

on Snake Creek Embankment

Part of the gigantic Garrison Dam project, in North Dakota, the Snake Creek Embankment will impound run-off water on a tributary of the Missouri. Four million yards of rolled earth fill make it a big operation in itself.

For efficient earthmoving on this job, Lytle & Green Construction Co. uses six "Caterpillar" DW20 Tractors and No. 20 Scrapers. The big yellow rigs average 14 trips each per hour on a ¾-mile haul, with 12-yard payloads of wet, sandy clay loam. And they work 20 hours a day.

The owners say: "The DW20s are hauling a great deal of yardage under bad conditions. They have very high haul speeds and powerful engines."

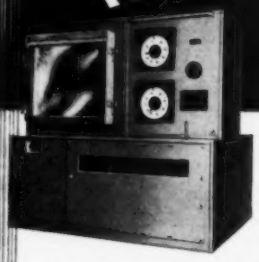
CATERPILLAR, PEORIA, ILLINOIS

CATERPILLAR

REG. U. S. PAT. OFF.

DIESEL ENGINES
TRACTORS • MOTOR GRADERS
EARTHMOVING EQUIPMENT

HIGH ALTITUDE TESTS



Bowser High Altitude Test Chambers furnish complete yet compact facilities for the testing of aircraft instruments and equipment at any and all altitudes. Included in the chamber are provisions for testing under wide conditions of temperature ranging from +200°F. to —150°F., as well as relative humidity from 20% to 95%. Bowser Test Units produce conditions within the limits called for in all Government environmental testing specifications.

Bowser makes the only complete line of testing facilities including Sand and Dust, Explosion, High and Low Temperature, Fungus, etc. Units are available from small self-contained laboratory sizes to large prefabricated walk-in rooms. Our Engineering staff is always ready for consultation. Take advantage of Bowser's long uninterrupted experience, the broadest in its field.

CHECK AND MAIL TODAY

BOWSER TECH. REFRIG., Terryville, Conn.

Send information on test equipment checked:

☐ High Temperature	☐ Fungus Resistance
☐ Low Temperature	☐ Rain and Sunshine
☐ Temperature Shock	☐ Sand and Dust
☐ Humidity	☐ Immersion
☐ Altitude	☐ Explosion Proof
☐ Walk-In Rooms	☐ Vapor Tight

Name_____ Pos._____

Company_____

Street_____

City_____ Zone____ State_____

BOWSER

TECHNICAL REFRIGERATION

DIVISION BOWSER INC.

TERRYVILLE • CONN

"Standard"

Serves Manufacturers Who Use All Shapes and Sizes of MECHANICAL STEEL TUBING

SIZE AND THICKNESS CHART

of Electric Weld Tubing for Mechanical Use

TUBE DIAMETER "O.D. SIZE	MAXIMUM WALL		MINIMUM WALL	
	DECIMAL	B. W. GAUGE	DECIMAL	B. W. GAUGE
1/2"	.065"	16	.028"	22
5/8"	.065"	16	.028"	22
3/4"	.065"	16	.028"	22
7/8"	.083"	14	.028"	22
1"	.109"	12	.028"	22
1 1/8"	.109"	12	.028"	22
1 1/4"	.134"	10	.028"	22
1 3/8"	.134"	10	.028"	22
1 1/2"	.148"	9	.035"	20
1 5/8"	.148"	9	.035"	20
1 3/4"	.148"	9	.035"	20
1 7/8"	.165"	8	.035"	20
2"	.165"	8	.035"	20
2 1/4"	.180"	8	.035"	20
2 1/2"	.203"	7	.035"	20
2 3/4"	.203"	6	.035"	20
3"	.220"	6	.035"	20
3 1/4"	.220"	5	.049"	18
3 1/2"	.238"	5	.049"	18
3 3/4"	.238"	4	.049"	18
3 7/8"	.238"	4	.049"	18
4"	.238"	4	.049"	18
4 1/4"	.238"	4	.049"	18
4 1/2"	.250"	4	.049"	18
4 3/4"	.250"	3	.049"	18
5"	.250"	3	.065"	16
5 1/2"	.180"	3	.083"	14
	.180"	7	.083"	14
		7	.083"	14

Intermediate sizes within the range indicated can also be manufactured. Please consult us for sizes not listed.

ABOVE CHART COVERS ROUND CARBON STEEL TUBING . . .

•

EQUIVALENT SQUARES, RECTANGULARS AND SPECIAL SHAPES ARE ALSO AVAILABLE.

Convair pioneers 1st atomic plane!

It's no longer just theory. Convair's exceptional engineering talents will be employed to harness *atomic power* to aircraft *performance!* The U. S. Air Force has awarded Convair the contract to develop America's first atomic-powered airplane, and General Electric—working jointly with Convair—will develop its nuclear propulsion system. The job will be done . . . adding another first to the already impressive list of Convair's achievements in designing aircraft of the future. This contract is still another tribute to Convair research-engineering-production teams . . . and to the far-sighted corporate management which makes A-plane development possible!

ENGINEERING TO THE "Nth" POWER . . . literally! The Air Force, Atomic Energy Commission, Convair and General Electric are working closely together to advance America's defense program. Always the goal at Convair is the production of power to achieve the *maximum degree* of performance. The maximum, the Nth degree of air power . . . *the Nth Power . . . Atomic Power*

ENGINEERING TO THE Nth POWER

In the air it's

CONVAIR

CONSOLIDATED VULTEE AIRCRAFT CORPORATION • SAN DIEGO CALIFORNIA • POMONA CALIFORNIA • FORT WORTH TEXAS

VERSATILE, ALL-WEATHER

22-TON CARGO-CARRIER

built by Allis-Chalmers

MODEL **M-8E2** SPEEDS TO 40 MPH.

Big guns can be moved and positioned in a hurry with this new, giant prime mover. The M-8E2 pulls 90 mm. antiaircraft guns, 155 mm. artillery pieces and eight-inch Howitzers. Carries ammunition, supplies, supplementary equipment and gun crews. Travels through swamps, across small trenches, up and down slopes as steep as 60 percent . . . turns in its tracks!

Two separate front seats carry the driver and assistant driver. The assistant has access to dual controls as well as radio controls. He also operates a .50 caliber machine gun mounted directly above him.

The tractor's usefulness is widened through interchangeable "kits." Among these are bulldozer kits for construction work, stake body kits for general cargo and personnel transport and wrecker kits for hauling damaged equipment.

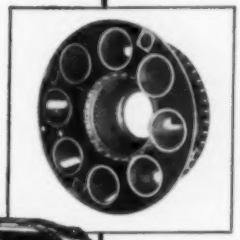
Many of the M-8E2 parts are interchangeable with those of vehicles in the light tank family, which greatly simplifies servicing and the stocking of replacement parts.

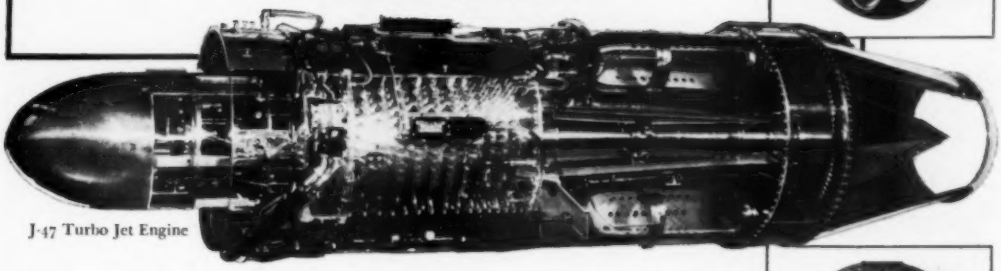
ALLIS-CHALMERS

TRACTOR DIVISION — MILWAUKEE 1, U. S. A.

JET ENGINES
and
COMPONENTS
by
FAIRCHILD

Rear Frame

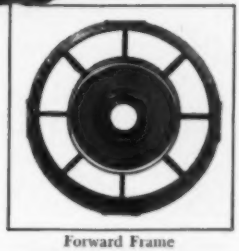




J-47 Turbo Jet Engine

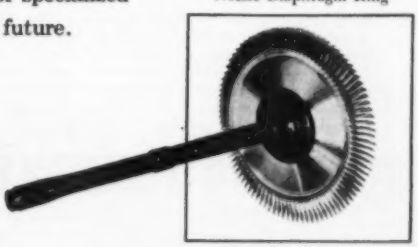
The Fairchild Engine Division is designing, and producing specialized turbine engines—some of them for unconventional applications—and is mass producing such vital components of General Electric's J-47 engine as the turbine wheel and shaft, nozzle diaphragm, and the forward and rear compressor frames—main supporting structures of the engine.

Geared to the exacting requirements of aircraft engine production, Fairchild is able to meet the expanding demands of the military establishments and take its place in the rearmament program; producing in volume urgently needed components and pressing forward the development of turbine and reciprocating engines for specialized application in the military equipment of the future.



Forward Frame

Nozzle Diaphragm Ring



Complete Turbine Wheel Assembly

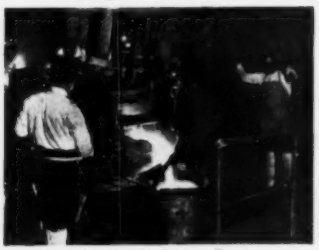
ENGINE AND AIRPLANE CORPORATION
FAIRCHILD
Engine Division
FARMINGDALE, N. Y.

Other Divisions: Fairchild Aircraft Division, Hagerstown, Md., Chicago, Ill. • Fairchild Guided Missiles Division, and Stratos Division, Farmingdale, N. Y.

SUPERIOR
in more than name

SEMI-STEEL END BELL for totally enclosed electric motor; partially machined showing finned surface which enhances heat dissipation. Gives rigid bearing support. Possesses excellent vibration damping characteristics.

...here is the modern equipment behind every Superior Gray Iron Production Casting



Complete Electric Furnace Process

Continuous Drying Ovens

Complete Metallurgical Control

High Speed Continuous Mold Conveyors

THESE are just a few of the modern facilities that enable Superior to produce castings ranging from 1/2 lb. to 1200 lb. in any quantity and to your particular specifications. Whether you want straight cupola gray iron or electric furnace iron castings with or without alloys, you'll discover that Superior Foundry's complete metallurgical control assures uniform grain structure, adherence to your specifications and a clean, smooth finish. Bring your production casting problems to us today.

SUPERIOR FOUNDRY, INC.

3542 EAST 71st STREET • CLEVELAND 5, OHIO

Member of: Gray Iron Research Institute • Gray Iron Founders Society

VUlcan 3-8000

ATOMIC ENERGY

ATOMIC AIRCRAFT

Development of materials capable of withstanding high temperatures and intense radiation is a problem of "unusual and critical degree" in an atomic power plant for aircraft, according to Dr. Miles C. Leverett of the General Electric Aircraft Nuclear Propulsion Project which is responsible for developing an aircraft nuclear power plant for the Atomic Energy Commission and the U. S. Air Force. Dr. Leverett recently discussed this and other problems before the Chicago Section of the Institute of the Aëronautical Sciences.

"Organic compounds are particularly susceptible (to deterioration from radiation), and even outside the zone of most intense radiation in the reactor ordinary lubricants turn tarry or even solidify," he said. "Lubricated machinery hence may not be used in such locations."

Some liquids or gases which might be used as coolants are decomposed by radiation, Dr. Leverett noted, and electrical insulation, upon prolonged exposure, breaks down and disintegrates or loses its effectiveness.

He predicted that efforts to fly an aircraft on nuclear power will be successful despite great engineering problems and said: "The difficulty of the task and the value of the result combine to form a challenge which is, in my opinion, unmatched."

Pointing out that one pound of fissionable material such as uranium 235 contains heat equivalent to 1,700,000 pounds of gasoline, the nuclear engineer pictured a plane in which fuel consumption would be measured in pounds per day rather than thousands of pounds per hour. Some of the far-reaching implications are an airplane which could stay aloft for many days, fly entirely around the world at local midnight, accomplishing the entire circuit under cover of darkness, and fly at maximum speed and at any desired altitude for all of its mission.

The Air Force announced recently that the Consolidated Vultee Aircraft Corporation, San Diego, Calif., is to supply an airframe for an atom plane. General Electric's Aircraft Gas Turbine Department, Lockland, Ohio, is to develop the propulsion system under contract with the Air Force and the Atomic Energy Commission.

Noting that the energy of fission from a nuclear reactor source is manifested as heat which must be converted into thrust or mechanical work, Dr. Leverett said an aircraft reactor consists basically of

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Atomic Energy

"a more or less cylindrical body throughout which a fissionable material, such as uranium 235 or plutonium 239, is distributed." Such a reactor contains passages for the flow of a heat-removing coolant and a material called a "moderator" which helps control neutrons liberated in the fission process. Typical moderators are graphite, ordinary water, heavy water, beryllium, and beryllium oxide.

Many proposals for a power plant have been made, including turbine-driven propellers, a turbojet in which the reactor takes the place of combustion chambers, and a ramjet engine with similar substitution of a rector for combustion apparatus. In all cases, except that of the ramjet and other direct air cycles, it is required that heat be transported in a coolant from the reactor to the propulsion machinery.

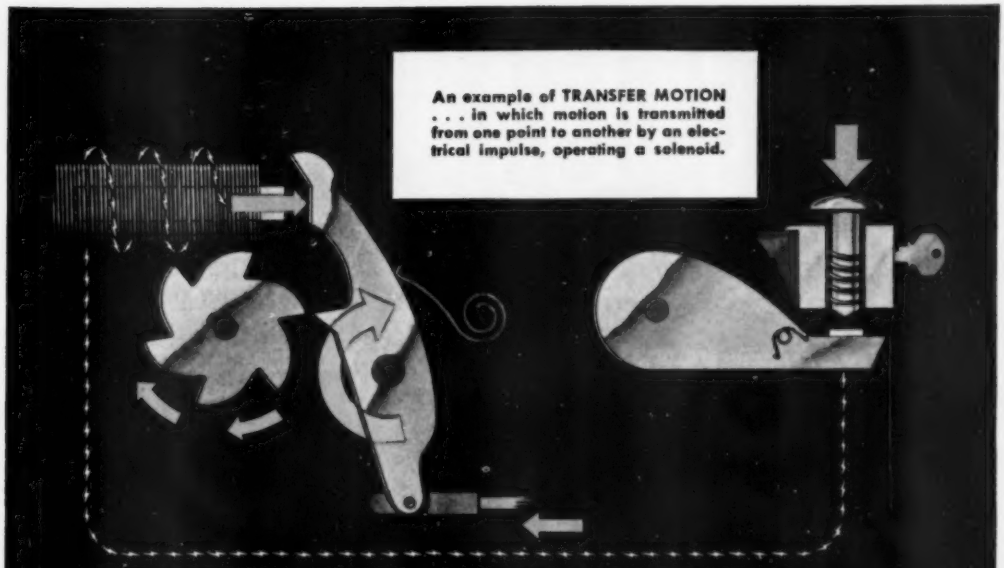
Turning to the problem of the shielding necessary to protect the crew and plane from dangerous radiation, Dr. Leverett noted that without shielding it would be necessary for humans to remain a mile away from a high-powered reactor in operation.

It is occasionally suggested that a nuclear aircraft will create a hazard to the population in its vicinity. However, inasmuch as the aircraft itself will carry a crew which must be protected adequately, persons at a distance will not be affected in any way. Since shield weight and dimensions for an aircraft reactor must be kept small, the detailed solution of this problem is extremely complicated. Shield weight is estimated at a minimum of 50 to 100 tons, necessitating a large aircraft designed to carry a great weight concentrated at one point.

Since the gross weight of a nuclear plane will be approximately the same on landing as on take-off, the landing gear must be made strong enough to take the higher gross landing weight. Moreover, the landing speed is increased, and there may be a change in landing attitude which possibly could require changes in the landing gear or in tail clearance angle requirements.

Much investigation must be done to determine the effects of radiation damage on materials used in reactors or exposed locations in the shield. One of the most important problems in reactor technology today is the finding and development of materials adequate for use in reactors which are proposed for production of power in one form or another. The combined effects of high temperature, corrosion by various coolants, radiation damage, thermal and mechanical stresses can be extremely serious in some cases. The aircraft reactor presents these problems to an unusual and critical degree.

Finding materials adequate to with-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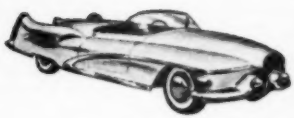

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The "motion" illustrated above is one in which our research and engineering ingenuity have been applied in the development of a mechanism designed for electrical operation of an automobile door—for General Motors' experimental Le Sabre car. Just as Le Sabre represents forward-looking automotive design, so does Standard Products engineering "look ahead" in the design of special types of motion-mechanisms. We can design similar mechanisms to operate either electrically *or* manually—*or both*.

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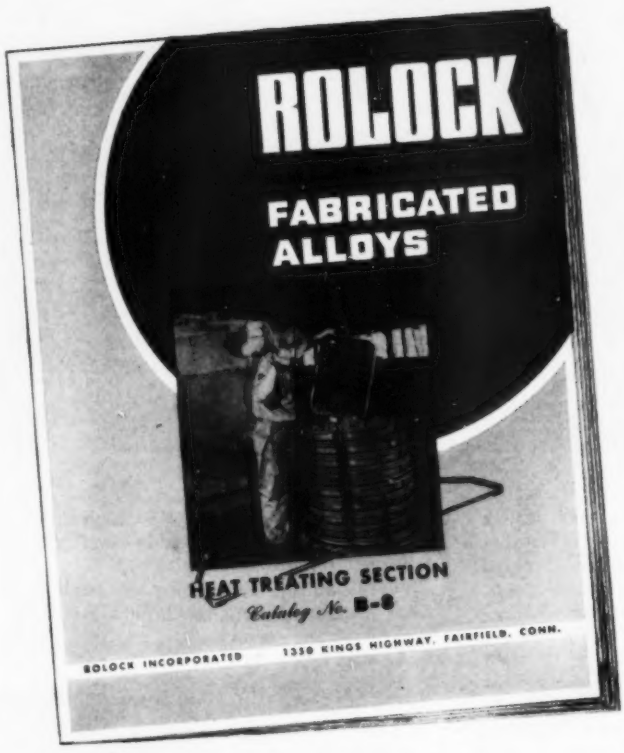

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stand these conditions is a challenge worthy of the best metallurgist, ceramist, and chemist. "In many respects the propulsion of aircraft is an ideal use for nuclear energy," Dr. Leverett added. "Here, to a higher extent than in any other application, the advantages of a highly concentrated source of heat can be used to good results. . . Moreover, it is inescapable that a development of this type has great military significance."

RADIATION FOR INDUSTRY

Thousand-curie sources of gamma radiation have been made available to assist industrial organizations in studies of the applications of radiation to industrial processes.

The thousand-curie sources, made of cobalt 60 or tantalum 182, each release as much gamma radiation as do 2.2 pounds of radium (an amount equal to the pre-World War II total world supply). Two such sources, one cobalt and the other tantalum, have been prepared in the Brookhaven National Laboratory nuclear reactor. Additional thousand-curie sources will be made as needed.

The sources were prepared as part of a program organized by the Atomic Energy Commission and university laboratories to determine the feasibility and safety of using radiation from by-products of nuclear reactors in killing bacteria or initiating or accelerating chemical reactions. Industrial concerns now can arrange with Brookhaven to have small samples of materials or products they wish to study exposed to radiation from the sources. Then, since materials so exposed do not themselves become radioactive, the samples can be easily returned to the sender for analysis and evaluation of the results of their irradiation.

Exposure to large quantities of radiation from atomic-energy by-products—also obtainable from sources such as X-ray machines or electrostatic generators—is known to induce chemical changes in molecules. Under intense gamma-radiation bombardment some molecules break into parts and then recombine in a different way. Brookhaven scientists already have used radiation from a cobalt source to induce polymerization, or the building up of large molecules out of small ones.

As a second part of the program to develop industrial applications for radioactive by-products, Brookhaven is assisting universities holding related research contracts with the Atomic Energy Commission.

Further information on the availability of the Brookhaven irradiation service to industrial concerns can be obtained from the Director's Office, Brookhaven National Laboratory, Upton, N. Y.

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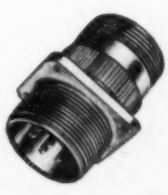

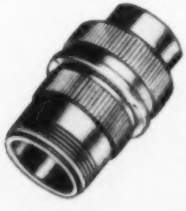

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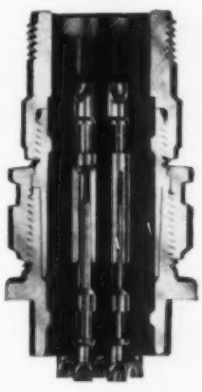

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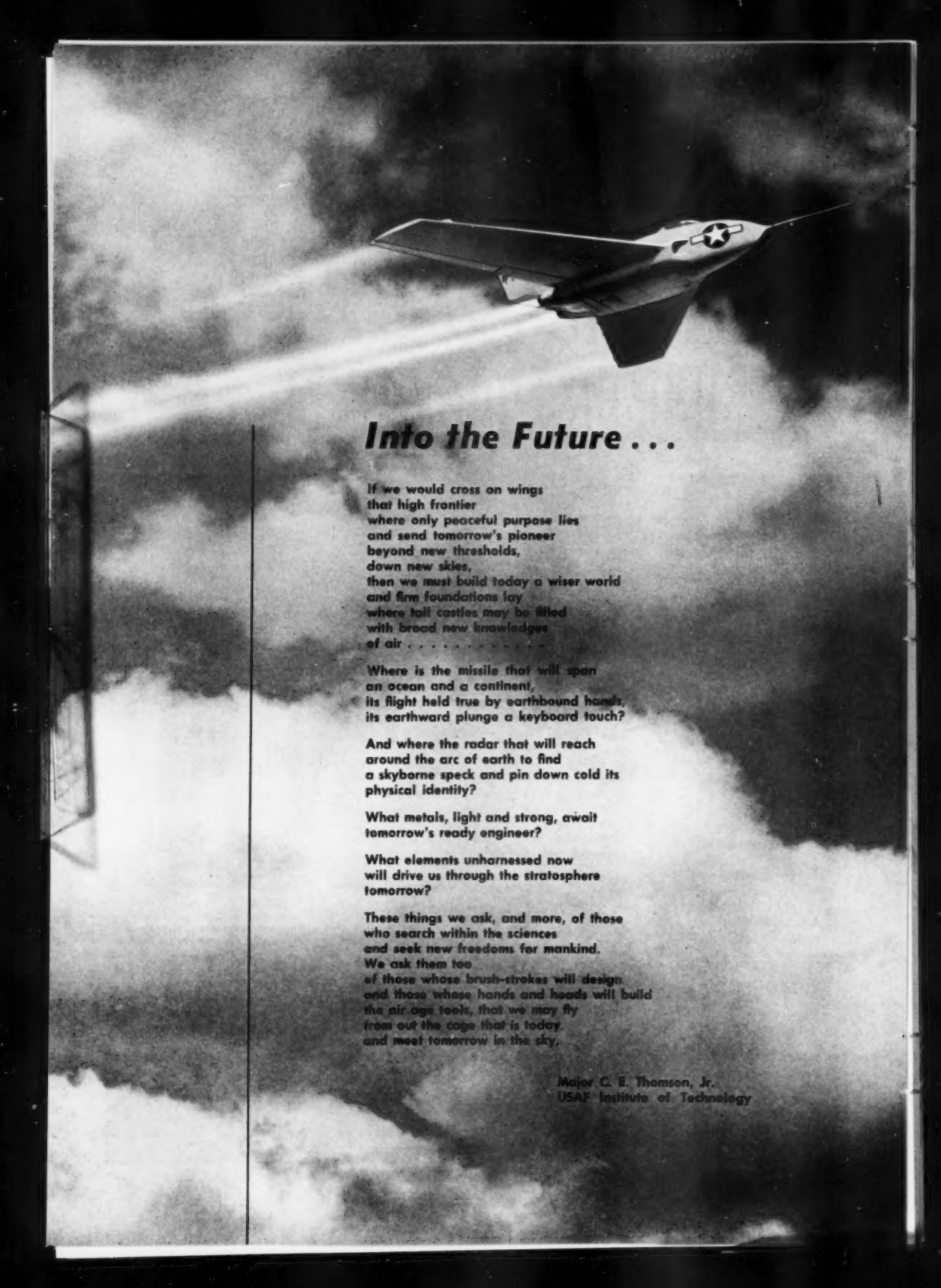


Into the Future . . .

If we would cross on wings
that high frontier
where only peaceful purpose lies
and send tomorrow's pioneer
beyond new thresholds,
down new skies,
then we must build today a wiser world
and firm foundations lay
where tall castles may be filled
with broad new knowledges
of air . . . . . .

Where is the missile that will span
an ocean and a continent,
its flight held true by earthbound hands,
its earthward plunge a keyboard touch?

And where the radar that will reach
around the arc of earth to find
a skyborne speck and pin down cold its
physical identity?

What metals, light and strong, await
tomorrow's ready engineer?

What elements unharnessed now
will drive us through the stratosphere
tomorrow?

These things we ask, and more, of those
who search within the sciences
and seek new freedoms for mankind.
We ask them too
of those whose brush-strokes will design
and those whose hands and heads will build
the air age tools, that we may fly
from out the cage that is today
and meet tomorrow in the sky.

Major C. E. Thomson, Jr.
USAF Institute of Technology

Ordnance and Standards

Dr. Allen V. Astin Is an Expert in Both Fields

A RECENT news story stated that the Army's catalogue of automotive items has been reduced from a Second World War high of 700,000 replacement parts to a current listing of only 125,000 parts.

Here is a highly praiseworthy achievement in standardization. This excellent record of progress in a very technical and difficult field also emphasizes the close relationship that has always existed between Ordnance and standards from the latter part of the eighteenth century, when Springfield Armory produced only twenty muskets a month, to our own day, when Army Ordnance, in a few wartime years, produced more than four million Garand rifles.

The manufacture of so comparatively simple a vehicle as a jeep used to require 2,500 different parts, totaling 9,000 individual pieces. During World War II, Ordnance had to stock and furnish more than a thousand different spare parts for this one small vehicle alone.

The Ordnance Record

The magnitude of the problem of standards can readily be seen from a brief reference to the astonishing record of Ordnance during the war years. In 1944 Ordnance handled more than two million parts orders a month, covering more than a hundred million items, and exported every month more than half a million tons of parts.

Ordnance is the keystone of interchangeable parts. Beginning with small arms, the value and practicality of the process was quickly recognized by industry.

In each succeeding decade of the industrial revolution, Ordnance and industry have been vitally concerned with this basic problem because the prosperity and security of the Nation depended in large measure upon the ability of military and civilian leaders to master and control this critical area of industrial production and maintenance.

Today the problem of standards is assuming ever-increasing importance because of the ever-growing multiplicity of military and industrial products and their increasing complexity.

Since Ordnance and industry are partners and coworkers in the greatest rearmament program in world history, it is heartening to know that both institutions are working together so harmoniously and fruitfully to solve the difficult problems of standardization.

Nation Is Fortunate

The Nation is particularly fortunate, in this critical period of our national defense program, that the leadership of the National Bureau of Standards should be entrusted to a distinguished scientist and weapons expert who is not only familiar with Ordnance problems but has made a substantial contribution to Ordnance progress in recent years.

For his pioneering work in the development of proximity fuzes for bombs and rockets, Dr. A. V. Astin was awarded the President's Certificate of Merit, the War Department Certificate of Appreciation for Outstanding Service, and (from Great Britain) His Majesty's Medal for Service in the Cause of Freedom.

Dr. Astin's appointment calls attention once again to the importance of the patient and productive work being carried on by civilian scientists and engineers who are devoting their exceptional talents to government service, very frequently without adequate recognition or compensation.

The American Ordnance Association is proud to honor this outstanding public servant and, in paying tribute to him, to honor at the same time his civilian colleagues in all branches and departments of Government who, without fanfare, have done so much to preserve our precious heritage of freedom and peace.

Dr. Allen V. Astin, Government scientist and weapons expert, whose photograph appears on the front cover of this issue, has been appointed Acting Director of the National Bureau of Standards.

A large part of the Bureau's research in mathematics and the physical sciences conducted for the Department of Defense has been under the supervision of Dr. Astin. As Associate Director of the Bureau he was responsible for the activities of the Division of Electricity, Electronics, Ordnance Development, Missile Development, the Office of Basic Instrumentation, and for the coördination of Bureau operations with other Government agencies.

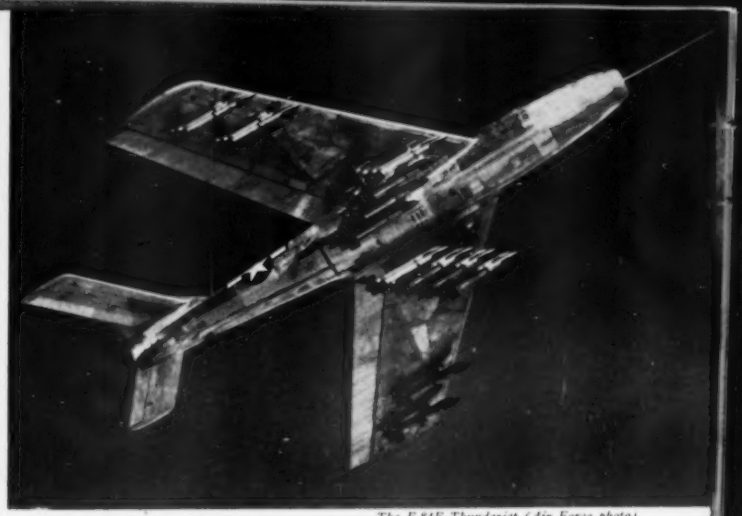
Dr. Astin was one of the original group of scientists assembled at the Bureau in 1940 to develop proximity fuzes for bombs and rockets. He played a major part in the development and evaluation of these fuzes and in their introduction to service use during the war.

Prior to the war Dr. Astin was active in research and development in dielectrics and in electronic instrumentation. In these fields he made a number of important contributions.

Born in Salt Lake City, he attended the University of Utah and New York University. He was a National Research Fellow at Johns Hopkins University and a Research Associate for the Utilities Research Commission of Illinois.

In 1932 Dr. Astin became a permanent staff member of the National Bureau of Standards. In 1944 he was appointed assistant chief of the unit now organized as the Ordnance Division.

MAJOR THOMSON, *author of "Into the Future," wrote this poem expressly for the occasion of the Thirty-Third Annual Meeting of the A.O.A. at Wright-Patterson Air Force Base, Dayton, Ohio, October 5, 1951.*



The F-84F Thunderjet (Air Force photo)

Aircraft Armament

Our Aërial Weapons Have Not Kept Pace with the Recent Advancements in Aircraft Speed and Performance

Brig. Gen. Gordon A. Blake

IN discussing the status of our aircraft armament I would like to begin with two basic points: First, how does the Air Force define the term "armament"? Secondly, in what environment does our aircraft armament perform its function? Both these points are essential to any discussion of our current status.

Armament Defined

In one of our Air Force Regulations —number 136-4—we define armament as follows: "Armament includes atomic and radiological weapons; biological weapons; bombs; guns; ammunition; guided missiles; rockets; chemical weapons; protective armors; sighting, launching, and control systems together with components, accessories, fixtures; handling, training, analyzing, and test equipment; targets, and the like, necessary to accomplish the Air Force mission."

You can readily see that our idea of armament is a very broad one. It is not at all limited to the actual weapon of destruction such as the bomb, gun, rocket, or guided missile.

In Air Force terminology armament also includes the information-gathering function and the computations which produce aimed fire. Thus in a fixed-gun interceptor the armament system would include: a radar and optical sight to determine target position; certain data about the interceptor's movements, such as air speed, heading, and so forth; a means of setting in ballistic information; a computer to convert all these inputs into lead angle and other aiming data; a presentation which the pilot can follow in the cockpit; and, lastly, a destructive device such as a gun or rocket with associated apparatus to fire it at the proper instant.

Robot Pilot

Furthermore, in the automatic interceptor of the future the autopilot, which would receive control signals through the fire-control computer, would be a part of the armament system.

The second basic point concerns the environment in which our armament systems function. In approaching this we must bear in mind the Air Force concept that the complete combat aircraft is our weapon. Our combat aircraft must be designed as a complete entity to be effective in the air warfare of today. This is quite a change from the time when we made aircraft to the maximum performance and then hung on such armament as was available and could be operated conveniently by such crew as could be carried.

Since World War II there have been significant changes in aircraft performance—the jet engine has given us a jump in both speed and altitude. This increased engine performance has caused significant changes in environment — one needs only to consult a table showing the physical composition of the atmosphere at 40,000 or 50,000 feet to grasp this point immediately.

Capability for night and all-weather operation—with its attendant dependence on radar and flight instruments—is also a fundamental part of our requirement.

Difficult Environment

It can be seen, then, that our aircraft armament must function at altitudes above 40,000 feet, at speeds near or greater than the speed of sound, under all conditions of weather or visibility, and in all parts of the globe. I think you will agree that such an environment gives us plenty to do in achieving effective armament.

Taking a broad look at the present status of our aircraft armament I think it is fairly obvious that the armament system has become a very complex collection of equipment by comparison with the equipment of ten years ago. This complexity is brought about by the requirement to function successfully in the environment I have described.

In this situation me might rephrase

the question, "What is the status of our aircraft armament" by asking instead, "How well do our armament systems meet their environment?" In answering this question I could describe in detail the status of individual projects such as bombing systems, defensive turrets for bombers, interceptor fire control and associated weapons, guns, rockets, and associated fire control for ground strafing.

Two Premises

However, such a detailed breakdown would require too much time. So I will limit my further remarks to two important premises which are common to all our armament systems: First, aircraft armament is lagging behind the performance of the aircraft and its power plant; and, secondly, aircraft armament, with its great dependence on electronic techniques, is lacking in reliability.

Here are a few illustrations on my first premise as to how armament lags behind aircraft performance.

We are fighting in Korea with practically the same aircraft guns used in World War II. These guns are the Browning caliber .50 and the Hispano 20-mm. While it is true that some improvement has been made, nevertheless the cyclic rates and the terminal effects fall short of the need occasioned by jet fighter speeds.

Lack of Emphasis

This situation is brought about in this country largely due to lack of emphasis in the past on aircraft guns and on the great length of time consumed in bringing weapons up to the required standard of reliability.

Likewise, in bombing we are operating at much higher altitudes. This moves back the bomb-release point and requires that the bombardier "see" his target from a much greater distance for proper aiming.

For example, at 40,000 feet—using a 500-pound bomb with no wind—a bombardier would use 130 seconds under ideal conditions. This time would be consumed as follows: target identification, 30 seconds; course correction, 20 seconds; cross hairs on target, 10 seconds; memory point solution, 15 seconds; start second memory point, 30 seconds; second memory point solution, 15 seconds; final solution, 10 seconds. In this ideal case the slant range would be 106,200 feet.

Of course, such ideal conditions are seldom encountered. As a minimum condition, 65 seconds can be used as follows: target identification, 30 seconds; crosshairs on target, 10 seconds; memory point solution, 15 seconds; final solution, 10 seconds.

This gives a slant range of 75,500 feet. Unfortunately, both optical and radar techniques leave something to be desired at these slant ranges. A periscope to do this job is quite bulky and complex. On the other hand, the radar portion of a bombing system simply does not have sufficient resolution to "see" the target in enough detail for optimum aiming. Thus our bombing error, while well within the limits of military usefulness, could be improved with great profit in terms of target destruction.

In the field of bombs, bomb-stowage, and bomb-release methods, we find that the greatly increased speed of jet bombers has necessitated extensive bomb redesign. Bomb bays, too, are giving trouble in high-speed releases, and extensive study work is under way on this problem.

In all these examples the pattern is the same—our armament is not yet optimized with relation to jet aircraft performance.

Let us turn now to the question of reliability. In this connection it should be noted that modern armament systems make extensive use of electronic techniques. It has been these electronic components which have given trouble due to temperature, humidity, altitude, and vibration found in aircraft installations.

The principal, but by no means the only culprit, is the vacuum tube. This is caused by the inherent weaknesses in tubes due to manufacturing methods and by the great number found in our armament systems. For example, one bombing system has several hundred vacuum tubes, and one of our interceptor fire-control systems has more than a hundred tubes. There are, of course, many other electronic components—resistors, condensers, switches, etc.—which can cause trouble in addition to the tubes.

If I seem to single out electronics as "the skunk at the garden party," it is only because it is our largest single area of trouble.

"Debugging"

In passing let me assure you that we have plenty of "debugging" in mechanical, optical, explosives, propellent, and other areas. Ammunition feeding, largely a mechanical problem, and low-temperature rocket propellant performance are just two examples. All in all, the number of components which could cause failure in a complex armament system total hundreds or perhaps thousands.

It is an elementary equation in probability that the reliability of a given system is the product of individual reliabilities of the various "series" components in that system. A "series" component is one which, if it fails, will cause system failure. To show the effect of this equation, consider a system with 100 separate components, each having an average reliability of 99 44/100 per cent. In such a system we would multiply 0.9944 for 100 times and get a system reliability of 60 per cent.

It is evident that the components of a modern armament system must have an individual reliability several orders of magnitude greater than the reliability which is acceptable for the system as a whole.

General Blake is chief of the Weapons Components Division, Wright Air Development Center, Wright-Patterson Air Force Base, Dayton, Ohio. This address was delivered at the Netherland-Plaza Hotel, Cincinnati, Ohio, during the Aircraft Armament Session of the Thirty-Third Annual Meeting of the American Ordnance Association, October 4, 1951.

We might pause here to look at what happens when such a complex system is put into production.

Obviously, the trouble and cost incurred in development, production, and inspection of armament will increase as the number of individual components goes up. This is not a linear increase; as a rough guide the trouble and cost will vary as the square of the number of components used. This is because the number of components is itself increased and the probability of individual component failure must be reduced in the same linear fashion.

All this adds up to the fact that, mathematically speaking, the price of complexity may have to be paid in terms of reliability.

I have already indicated that, for the most part, the increasing complexity of our armament comes from a requirement for increased performance. However, we should not overlook one important factor which can produce unnecessary complexity. I am referring to poor design. In particular there is a dangerous trend toward complexity which is characteristic of the thinking done by some scientists and designers who become interested in the theoretical function of a complex component. Very often this may result in an impractical design.

Information Needed

Along the same line, the designer may not be familiar enough with service conditions which his equipment will encounter. Here is an area where the Air Force laboratory and its engineers must function effectively in dealing with its contractors. Advice as to service conditions must be made available and detailed design influenced by these engineers.

Also, the contractor's people are often shown the actual operating conditions by visits to the tactical units—we have found that even top management can benefit from this process. For example, every time a key executive from a contractor visits the B-36 squadrons at Fort Worth, we find accelerated progress in the plant after he gets back to his desk.

Both of these premises—that aircraft armament is not up to aircraft performance and that it lacks reliability—give a gloomy picture to our current status. Actually, from a practical standpoint, we are not that badly off.

This is true because I have compared our armament with our aircraft and with an arbitrary standard of reliability. The only valid comparison in this respect is with the capability of potential enemies. A shooting war is required to make this analysis. Since we have one going on in Korea, let us look at the results.

"Aircraft armament is lagging behind the performance of the aircraft and its power plant and, with its great dependence on electronic techniques, is lacking in reliability."

Interesting Results

While I don't believe we should use our Korean experience as a completely valid yardstick against what to expect in a total war, nevertheless some of the fighter-to-fighter encounters and air-to-ground results against matériel are interesting. A summary of available reports on fighter combat indicates that our combat effectiveness compared to the enemy's is twenty-five per cent greater than that enjoyed by the Eighth Air Force over the Luftwaffe in the air battle for Europe.

Concerning air-to-ground operations in Korea, I would like to quote a few statistics from the magazine *Air Force* which is the official journal of the Air Force Association. These are taken from a special issue in March of this year. According to an evaluation by GHQ—independent of the Air Force—based on 2,000 prisoner-of-war reports, air power has accounted for: 81 per cent of all enemy trucks destroyed, 75 per cent of all enemy tanks destroyed, 72 per cent of all enemy artillery destroyed, and 47 per cent of all enemy troop casualties. These figures are for all air units—Navy, Marine, and Air Force in Korean operations.

Although there is room for much improvement in air-ground support, particularly for night work, the evidence points overwhelmingly to the fact that aircraft armament can cause great damage to ground targets.

Ready To Go

There are types of air operation for which Korea gives us no clues—as for example our own Air Defense Command and the Strategic Air Command in its A-bomb mission. Here we must rely on analysis of results in the continuous, realistic training flights of these commands. I assure you they are both ready to go.

Summarizing the over-all position of aircraft armament we can state—as a "broad-brush" comment—that our capability today is well above the minimum necessary for our mission, but that the opportunity for improvement is immediate and challenging.

Here is where associations like the American Ordnance Association—and its members individually—can help us. As most of you know already, the Air Force relies primarily on our industries, research institutes, laboratories, and universities in the conduct of its research and development program.

In the field of basic ordnance items such as guns, rockets, bombs, and ammunition, we rely heavily on our sister services who in turn go to these same agencies for contract work.

In the last analysis, the Air Force can provide the problem, the funds, and guidance during the development and production process, but the imaginative detailed design must come from our contractors—either working directly with our laboratories or with the Army or Navy organizations which are helping us.

Winston Churchill—who is perhaps without peer today as a phrasemaker—once said, "For good or ill, air mastery today is the supreme expression of military power."

No Second Prize

We all know that there is no second prize in the race for air mastery. Your efforts in the past have been a tremendous boost in getting the Air Force armament where it is today.

Fairchild photo

New Ordnance Materials

Lighter, Stronger Metals and Plastics Will Increase Our Airborne Firepower

Col. Benjamin S. Mesick

WE view the broad program of research and development of materials for use in ordnance as consisting of two parts. The first, and by far the larger, is supported and conducted by American industry in its constant endeavor to provide new and improved materials for civilian use in aircraft, motor vehicles, farm machinery, business machines, radios, refrigerators, and hundreds of other items.

Ordnance Research

The second part consists of our specific Ordnance research and development program to provide materials which at present have no commercial counterpart and to encourage and promote the speedy development of those new and better materials which will lead to improved ordnance equipment. Limited by the availability of materials engineers, we keep abreast of industrial development and standardization of materials, procedures, and the various test methods.

We share with modern industry the complex problems of standardization of materials and test methods and conservation of strategic and critical materials. Although complicated Government procurement makes it necessary to maintain a system of Government-controlled specifications, the preparation and revision of our materials specifications are closely integrated with industrial efforts in the same fields.

This is done through our liaison representation on working committees of national technical societies including S.A.E., A.S.T.M., and others; through direct contacts with individual producers and suppliers and trade associations, such as the A.I.S.I. and Society of the Plastics Industries; and with direct assistance of the American Ordnance Association in solving special problems.

Materials Conservation

Conservation of strategic and critical materials must be borne in mind constantly by Ordnance designers and production engineers from the initiation of development of a new weapon or item of equipment to the preparation and release of detailed drawings for use in production. A conservation program is now under way at Ordnance engineering agencies. We are receiving, and expect to continue to receive, advice and assistance in this great task from technical experts in industry.

Steel is the predominant material of ordnance construction. The types, classes, grades, and combinations of physical properties are too numerous even to mention here. Just to indicate the wide scope, it can be said that we have applications identical with or closely paralleling practically all those of the combined aircraft, automotive, farm equipment, earth-moving, and other industries.

Three Factors

Armor for aircraft, tanks, and other combat vehicles requires combinations of physical properties, not required normally for constructional applications, to provide the maximum ballistic protection for the weight used. The three major factors are soundness, hardness, and toughness.

As a result of many years of research,

Colonel Mesick, now commanding officer of Watertown Arsenal, Watertown, Mass., was formerly chief of the Research and Materials Branch, Ordnance Research and Development Division.

During World War II, Colonel Mesick served as Ordnance Officer of the 10th Armored Division, as commanding officer of the 303rd Ordnance Base Regiment, and of the Pomona Ordnance Base. In the European Theater he was responsible for Ordnance planning and preparation for the invasion of the Continent.

Appointed by Chief of Staff Gen. J. Lawton Collins as coördinator of the Army Titanium Program, Colonel Mesick has been a leader in turning titanium from a laboratory curiosity into an engineering metal of great potentialities. He delivered this address at the Thirty-Third Annual Meeting of the A.O.A., Cincinnati, Ohio, October 4, 1951.

development, and testing, including the experience gained during World War II, we have established definite correlation between these properties and ballistic performance against conventional armor-piercing ammunition. This makes it possible to use tests which can be made in the laboratory for quality control and acceptance of armor. It is expected that the tremendous burden, expense, and delays associated with ballistic testing during World War II will be greatly reduced if not eliminated in current and future production.

Problems Not Great

To obtain the necessary soundness and high hardness with adequate toughness, as determined by low-temperature Charpy impact test, presents no serious or unusual technical problems to steel producers, fabricators, and foundries accustomed to supplying high-quality heat-treated steel plate or castings, except where thickness and mass are considerably greater than found in quenched and tempered parts for commercial use.

However, steel mills and foundries working in close coöperation with Watertown Arsenal have been able to obtain combinations of hardness and toughness in sections six inches and over in thickness which a few years ago would have been considered impracticable if not impossible.

During World War II, steel armor was welded with austenitic electrodes containing approximately eight per cent nickel and eighteen per cent chromium. Since then, Watertown Arsenal, in cooperation with other military and civilian research agencies, has continued the research started during the war by the National Defense Research Committee to provide ferritic electrodes suitable for welding armor and high-strength constructional steels.

Electrodes Available

This research, and the developmental work of industry, have resulted in the availability of limited quantities of ferritic electrodes and much of the technical information necessary to produce strong, tough welds in armor.

We look to industry for the expansion of production of high-strength ferritic electrodes, for the application of these to production welding on armored vehicles which will be necessary to conserve chromium and nickel, and for the development and application of automatic welding processes utilizing ferritic electrodes. The Ordnance Corps is supporting these efforts with continued research, development, and experimental production.

At this time we are keenly aware of the problems facing American industry because of the necessity for reducing to the absolute practicable minimum the use of alloys to obtain high strength, hardness, and other properties in engineering steels so essential to modern military and civilian equipment.

It is encouraging to note that major producers and users of steel many months ago recognized the necessity for action and have coöperated together through the S.A.E., A.I.S.I., and other organizations in developing and adopting alternate steel compositions and are continuing to work out together the production and application of boron-treated steels.

The Ordnance Corps has actively participated in the coöperative efforts in this field since the days of World War II and is conducting a vigorous program of advising and assisting our engineers and contractors in the use of the boron steels and other alternate compositions.

"The constant demand for improvement in performance with reduction in weight in all classes of ordnance equipment has led us to consider all kinds of constructional materials which provide a high strength-density ratio."

Although the severe reduction in alloys for engineering steels presents many complex problems, there is every reason to believe that, through the use of boron and other newer addition agents now being investigated and by utilization of advanced heat-treating methods and equipment, American industry and the Ordnance Corps can meet the challenge and produce weapons and equipment for every requirement of safety and performance. We can even go further and make them better than ever before.

Ductile Cast Iron

Other ferrous metals, including malleable and pearlitic malleable iron, are used in ordnance. We expect that the newer nodular graphitic (or ductile) cast iron also will find many applications. It already has found some uses in ammunition.

Heat- and erosion-resistant materials are becoming increasingly important to our success in providing new and improved weapons. To withstand higher velocities or increased rates of fire our guns, both large and small, must be lined with materials which not only retain strength at elevated temperature but will not be eroded or worn away at a rapid rate by hot gases and mechanical action of the projectiles. Some components of guided missiles also present complex materials problems.

The practical solution of these problems is made more difficult because thus far the most promising materials for such applications contain very high percentages of critical alloys, and it is therefore apparent that the development and evaluation of alternate materials must be accelerated.

Better Evaluation Needed

Before real progress can be made in this field, better laboratory methods of evaluation must be developed to provide a means of rapidly screening prospective materials. The methods must provide better means for classifying materials as to suitability for various conditions of service (temperature, time, stress, corrosive, and erosive factors). This is a task which should be undertaken coöperatively by industry and Department of Defense research agencies.

Although the tonnage of nonferrous metals used in ordnance is small when compared with steel, these materials play a vital part, particularly in artillery fire-control instruments and ammunition as well as in the conventional applications in motorized and mobile

equipment. Materials in this class offer the greatest promise of weight saving for airborne equipment.

Traditionally, cartridge brass, seventy per cent copper and thirty per cent zinc, has been used in larger quantities than all other nonferrous metals. Cartridge cases ranging from caliber .30 to 120-mm. are required by the million. The diminishing supply of copper and zinc and technical problems arising in connection with weapons of new design make it necessary to turn more and more to steel for cartridge cases, thus involving numerous problems that cannot be dealt with in a brief general discussion. Light alloys may be expected to replace copper alloys in some cases where weight saving is important.

Aluminum

Aluminum alloys, because of their potential criticalness during a large military production program, generally are used in ordnance equipment only where they provide a great advantage over less critical materials. During World War II, Ordnance was allowed very little wrought aluminum alloy products since these must be made from primary metals and carefully segregated scrap.

However we were permitted to use considerable quantities of castings made from alloy ingots which the smelters were able to produce within reasonable composition limits from miscellaneous mixed aluminum scrap.

The outstanding result of coöperation among the smelters, the die-casting industry, and the Ordnance Corps was Specification AXS-679 under which were procured millions of die-cast parts, mostly ammunition components. The series of die-casting alloys covered by this specification and its successors, which require no primary aluminum, has found wide use in industry and will continue to be used for many applications in ordnance.

Magnesium

The constant demand for improvement in performance with reduction in weight in all classes of ordnance equipment has led us to consider all kinds of constructional materials which provide a high strength-density ratio. Although much can be accomplished through the use of high-strength steels, there are many applications where further savings cannot be made through reduction of section thickness, and therefore we must look to materials of lower density. Because of the natural limitation on availability of aluminum, we turn to magnesium which potentially can be produced in larger quantity.

"The availability of titanium ore and the exceptional strength of the alloys at normal temperatures, plus unmatched corrosion resistance, make it appear certain that they will be used in many ordnance items where it is important to reduce weight and improve performance."

Several factors have retarded the wide use of magnesium alloys in ordnance design. While lack of definite knowledge of the possibilities and limitations of these materials and limited experience in their fabrication undoubtedly have been the chief deterrents, poor resistance to abrasion, heat, and corrosion also have been real obstacles.

Supply Unlimited

However, the practically unlimited availability of raw material, particularly magnesium salts in sea water, and the steady progress in development of alloys with better physical properties, such as has resulted from Army supported research by Dow Chemical Company, has caused the Ordnance Corps to continue the search for solutions to the various technical problems.

Frankford Arsenal has developed a surface treatment for magnesium known as the H-A-E coating. This revolutionary new coating provides superior corrosion resistance as demonstrated by ninety hours' exposure to salt spray without visible effects and by contact with other metals without appreciable galvanic corrosion. It will withstand severe abrasion tests and is not noticeably affected by heat up to the melting point of the alloys. This development should greatly extend the field of useful application of magnesium alloys in military and commercial equipment.

Titanium

Titanium and titanium alloys should not be omitted from any current discussion of constructional materials of high strength-density ratio. Although these materials are not used in any ordnance item currently in production, the availability of titanium ore and the exceptional strength of the alloys at normal temperatures, plus unmatched corrosion resistance, make it appear certain that they will be used in many ordnance items where it is important to reduce weight and improve performance.

It is conceivable that titanium alloys can be substituted thickness for thickness for steel armor, reducing armor weight by about forty per cent. Similar weight savings in some structural components of airborne or manhandled equipment also are anticipated.

Rubber

As often stated, the mechanized Army of today literally rides into battle on rubber with the predominant use being in combat and transport vehicles. Successful use of rubber in military tanks, trucks, and other vehicles requires the same properties in the material and the availability of the same engineering data found necessary for civilian applications.

In addition, special characteristics must be obtained in some materials and more engineering data must be provided to meet the more severe conditions of military service. Some of these conditions are: suitability at extreme temperatures, resistance to unusual fuels and lubricants, maintenance of original properties after lengthy periods of exposure, and sufficiently high strength properties to permit operations on rough terrain found in battle areas.

In addition to meeting the specified military requirements, there is the ever-present problem of conserving our natural-rubber stock pile to assist in gaining independence of foreign sources of supply. This becomes ex-

ceedingly difficult when it is recognized that we must not only maintain minimum properties in the material but seek constant improvement.

The largest consumption of natural rubber is in large-size tires where an adequate replacement material has not been found. The Office of Rubber Reserve, in coöperation with the Ordnance Corps and industry, is actively prosecuting this problem, and an early and successful conclusion is hoped for.

One of the most difficult rubber problems in military equipment which the Ordnance Corps has been called upon to meet is the joint requirements of flexibility at low temperatures and resistance to oils and fuels. Extensive research is being conducted to develop improved materials, and several offer promise.

In non-oil-resistant applications, many rubber-plastic combinations, modified rubbers, and low styrene butadiene rubbers offer advantages and improvements relative to specific properties such as oxygen- and ozone-resistance, increased abrasion resistance and tear strength, and better low-temperature brittleness.

Plastics

Plastics are of interest to Ordnance for several reasons. Since, generally, they can be synthesized from organic sources, placing little or no demand on our mineral resources, availability of plastics is governed mainly by production facilities rather than inflexible natural limitations.

For this reason, from a long-range viewpoint plastics can be considered more expendable than most other classes of engineering materials. Consequently, for applications where the material in the item cannot be recovered, the use of plastics in lieu of metals represents conservation of natural resources.

With plastics it is possible to synthesize materials with a wide variety of physical as well as chemical properties. In addition, fabrication techniques have been and are being developed which permit much more flexibility of design than is obtainable with other materials.

The general public, unfortunately, frequently is made aware of the shortcomings of plastics due to the many misapplications in which they have involved. It is the aim of Ordnance to avoid improper usage. Those who have worked with plastics, on the other hand, are well aware of what they can do and are convinced that they should at least be considered in the development of every new item. Frequently the requirements for the item obviate the need for further discussion. For some uses, plastics simply will not work.

Recent Advances

On the other hand, the advances which have been made during the last few years are unfamiliar not only to the public but to many design engineers. There are plastics today with tensile strength of the order of 100,000 pounds per square inch, impact resistance of 25 foot-pounds, and flexural strength of 32,000 pounds per square inch.

These figures compare favorably with properties of metals. Ask the fisherman about the plastic-glass combination fishing rod. There are also several plastics which will withstand the extremely low temperatures which we may encounter in the event that we have to fight a war in the Arctic.

Plastics have proved themselves in such industrial applications as fuel lines, water-storage tanks, electrical housings, and wire insulation. It has been rather well established that the plastic-glass-fiber boat is here to stay. Plastics have proved satisfactory in the aircraft industry for many structural parts, for fuel lines, for windshields, and even in propellers.

The successful functioning of plastics in a number of these tough applications gives assurance that, at least from the standpoint of performance, plastics are worth considering in a number of structural components. Ordnance applications under development and being considered to reduce weight, solve corrosion and maintenance problems, and conserve critical materials include plastic hulls for amphibious trucks, plastic water tanks for mounting on trucks and trailers, plastic ammunition and stowage boxes, etc.

Adhesives

Until fairly recent years most structures were joined together by nails, screws, welding, soldering, rivets, and various mechanical means such as threaded or friction joints. With the advent of synthetic resins there began an intensive study to develop adhesives.

Initially, most of this work was concentrated on adhesives for wood. The success of this program was shown by the widespread use of large glued wooden parts for shipbuilding and aircraft construction. A further outcome was the development of a variety of combinations of different materials such as wood-metal, metal-plastic, plastic-glass, and many others.

Many of you are familiar with the use of marine-grade adhesives for bonding station-wagon bodies, adhesives for bonding rubber gaskets to metal door frames, cements for bonding brake shoes, and numerous other automotive applications. The Ordnance Corps, in addition to these problems, is concerned with sealing and luting compounds for protection of vehicles in deep-water fording operations and for securing watertight joints in general.

Special Problems

To these can be added the special problems of sealing artillery fire-control instruments and joining components of ammunition. It is necessary that adhesives for most of these applications be capable of withstanding extremes of temperature and other severe conditions to which military equipment is exposed.

This discussion provides indications of the scope of Ordnance interests and problems in the field of materials engineering. From experience during and since the last war we are convinced that, to the extent practicable, we should equip ourselves to make effective use of all available materials in order to promote the development of new and better ordnance equipment and practice true conservation of materials and effort in any emergency.

Rockets of the Navy

The Present Trend Is toward Lightness and Precision

Comdr. W. H. Keighley

Head, Rockets Section, Research and Development Division, Navy Bureau of Ordnance

THE rockets of World War II did not represent the invention of a new weapon but rather the modernization of an old one.

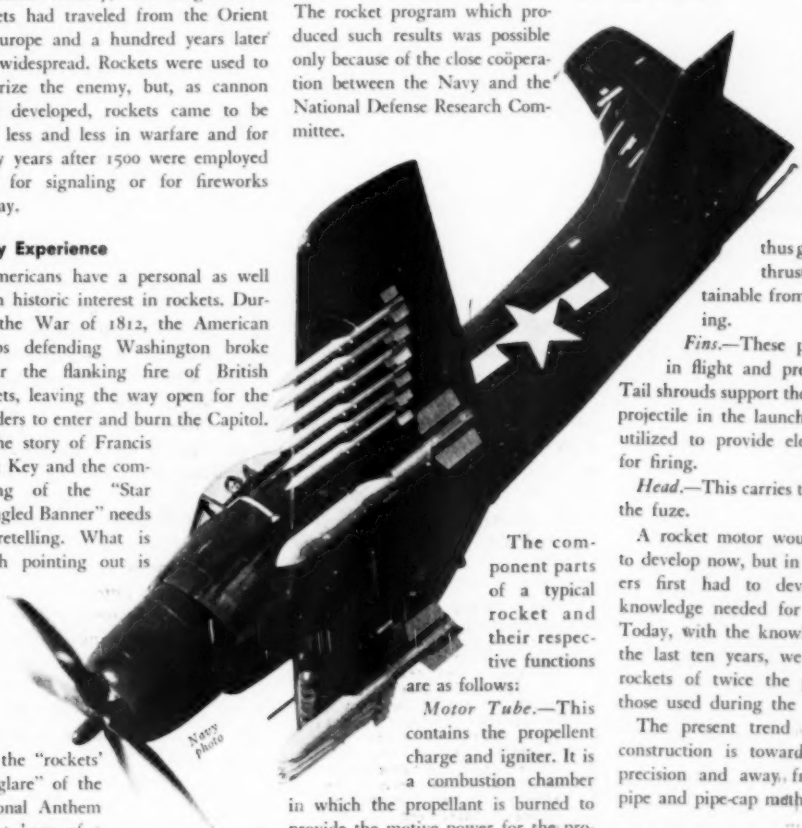
The Chinese are recorded as having launched rockets against Genghis Kahn as long ago as 1232. By the close of the thirteenth century, knowledge about rockets had traveled from the Orient to Europe and a hundred years later was widespread. Rockets were used to terrorize the enemy, but, as cannon were developed, rockets came to be used less and less in warfare and for many years after 1500 were employed only for signaling or for fireworks display.

Early Experience

Americans have a personal as well as an historic interest in rockets. During the War of 1812, the American troops defending Washington broke under the flanking fire of British rockets, leaving the way open for the invaders to enter and burn the Capitol.

The story of Francis Scott Key and the composing of the "Star Spangled Banner" needs no retelling. What is worth pointing out is that the "rockets' red glare" of the National Anthem is not born of a poet's fancy, because the British fleet included several vessels equipped for rocket firing. Rocket units sprang up in a number of European armies. In the United States a rocket battery was created in 1846 and ten more were organized the following year.

When the Japanese attack was made on Pearl Harbor there was not a single rocket in service use in the United States. By V-J Day, the Navy had 1,200 war plants turning out rockets at the rate of $100,000,000 a month. The rocket program which produced such results was possible only because of the close coöperation between the Navy and the National Defense Research Committee.



Navy photo

The component parts of a typical rocket and their respective functions are as follows:

Motor Tube.—This contains the propellent charge and igniter. It is a combustion chamber in which the propellant is burned to provide the motive power for the projectile.

Propellant and Igniter.—The igniter contains black powder and an electric squib. When a current is passed through the squib it ignites the black powder, filling the interior of the motor tube with hot gases, raising the pressure and temperature of the propellant to its proper operating value. As soon as the propellant begins to burn, it generates large quantities of gas. Flow of the gas out the nozzle produces thrust.

Nozzle.—The nozzle has two functions: it directs the gas jet in the desired direction, and it provides for expansion of the hot gases in the exit cone, thus giving additional thrust over that obtainable from a simple opening.

Fins.—These provide stability in flight and prevent tumbling. Tail shrouds support the rear end of the projectile in the launcher and may be utilized to provide electrical contacts for firing.

Head.—This carries the pay load and the fuze.

A rocket motor would not be hard to develop now, but in 1941 the workers first had to develop the basic knowledge needed for proper design. Today, with the knowledge gained in the last ten years, we are producing rockets of twice the performance of those used during the last war.

The present trend in metal parts construction is toward lightness and precision and away from the water-pipe and pipe-cap methods of the past.

No Recoil

The principal advantage of a rocket is its lack of recoil. Lacking recoil, a rocket can be fired from a simple light tube or trough which serves merely to

point the rocket in the right direction. Some barrage rockets can be fired from the shipping crates in cases of emergency. Lightweight launchers give the rocket a mobility enabling it to go many places impossible to a gun.

Large Size Rockets

The recoil of a 75-mm. cannon mounted in the nose of a medium bomber subjects the plane to an abrupt shock that requires substantial strengthening of the plane's structure. Aircraft rockets of larger size and much greater explosive loads can be fired from a fighter aircraft without affecting its flight. Today we have in production the "Mighty Mouse," 2.75 inches in diameter. This rocket has folding fins and will be carried in streamlined containers on all types of aircraft.

The "Mighty Mouse" rocket is a postwar development that has taken advantage of all the knowledge and experience acquired since the beginning of the last war. Aluminum is being used in this motor tube and in all rockets now under development. Plastic and fiberglas are being studied as alternate materials for the rocket motor tube.

The same principles and procedures used in the development of gun propellants are also followed to a greater or lesser extent in the application of solid propellant to a rocket.

Balance Needed

In the development of solid rocket propellants, however, a balance between two factors must be considered: (1) The burning of the solid propellant in the rocket motor tends to increase the pressure; and (2) The escape of the gases through the nozzle tends to reduce the pressure. A delicate balance between these two factors must be achieved in the design of a successful propellant grain for any particular rocket application.

Developments of solid propellants with improved physical characteristics have permitted an increase in the safe-firing and storage-temperature limits. Generally the previous temperature limits for rockets were from zero to 120 degrees Fahrenheit. Recent improvements in grain design have permitted a widening of the temperature limits from 60 below to 120 degrees above zero Fahrenheit, and it is possible that the upper limit will be raised in the near future.

Research is continuing on the development of better propellants for rockets. Recent investigations in the application of high-energy fuels to rockets have proved very satisfactory.

Every major nation used rockets in World War II. Each nation developed rocket weapons in answer to its tactical and combat needs. Russia pioneered in the use of massed banks of rockets for pre-assault barrages. The British used rockets for defense against attack from the air when there were insufficient antiaircraft guns in the United Kingdom. Germany employed the long-range V-2 weapon to attack England's cities. The Japanese attempted to use rocket artillery to defend their islands. The United States developed and introduced a great variety of rocket weapons.

Rockets of today have been developed to meet operational needs arising from tactical and strategic situations in a modern yet conventional type of warfare.

Rockets designed for firing from aircraft consist of fixed-fin, folding-fin, and spin types. They range in size from 2 to 14 inches in diameter and in weight from 9 to 2,300 pounds. The heads on these aircraft rockets are armor-piercing, semi-armor-piercing, high-explosive, flare, smoke, and shaped-charge. The 6.5-inch shaped-charge head was designed by the Naval Ordnance Test Station at Inyokern, Calif. This head was designed, produced, and put into service use in Korea in twenty-three days. It proved to be an excellent operational weapon against tanks and personnel.

Barrage Rockets

Other rockets are designed for amphibious warfare. The barrage rocket was designed to fill in the interval between the time the naval and air bombardment must be moved inland and the time the first assault waves hit the beach. It is this interval that gives the beach defenders the chance to organize and pour a murderous fire into the landing forces.

The barrage rocket enabled small craft, for the short period of the actual landings, to strike with the hitting power of destroyers against enemy strongpoints within small-arms range of the landing beaches. Barrage rocket ships fire 5-inch spin-stabilized rockets from about 1,000 to 10,000 yards at a high rate of fire.

The conventional type of antisubmarine attack during World War I depended on depth charges which were dropped in a pattern to blanket an area where the submarine was believed to be. These depth charges exploded when they reached a preset depth, causing the attacking ship to lose sound contact.

Undersea Rockets

The need was for projectiles which could be propelled ahead of the attacking ship in a pattern, while sound contact was maintained without interruption. Such a projectile was designed with a rocket motor and equipped with a fuze which would arm by hydrostatic pressure and then detonate only on contact with a solid object under water.

Service rockets at the end of the war had performance ratings of about 50 to 60. The rockets under development at present have performance ratings of the order of 110. This is significant progress, and we hope to be able to offer proportionate increases in performance in the future.

During World War II Commander Keighley participated in seven major battles of the Pacific Campaign as a naval aviator, sinking two destroyers in the defense of Guadalcanal and leading Composite Squadron 3 through the Battle of Leyte Gulf while his carrier was shelled by Japanese battleships. For action in this battle he received the Navy Cross to be added to his two Distinguished Flying Crosses and 14 Air Medals.

This address was delivered during the Aircraft Armament Session of the Thirty-Third Annual Meeting, American Ordnance Association at Cincinnati, Ohio, October 4, 1951.

U. S. Air Force

Continuous Development Creates Unbeatable Aircraft

Col. René R. Studler

AFTER five years in the Air Force, followed by almost thirty years in the development and production of aircraft guns and ammunition, I may be forgiven certain rather positive opinions about this class of matériel.

When my Ordnance career began in 1922, the caliber .30 machine gun reigned supreme. The caliber .50 was in its infancy. Recognizing that some day the caliber .30 would become obsolete, we worked hard to perfect the caliber .50.

Caliber .50 Needed

When the Second World War started, the caliber .30 was on its way out. The striking power of the caliber .50 was needed, and no time was lost by the United States Air Force and the Navy in installing caliber .50 M2 guns in aircraft. American industry made over one and a half million of these guns which were largely responsible for our air supremacy.

During the war we perfected the M3 gun which, at no increase of size or weight, fires at the rate of 1,200 rounds a minute—50 per cent more than the M2. The M3 is living up to the same reliability performance as the M2. One air group in Korea has reported the firing of two million rounds with only seventeen stoppages from all causes.

The record of combat kills in Korea shows a ratio of between five and ten MIG kills per United States loss. Since the planes are considered to be about equal in flight performance, the margin of superiority must be attributed to the pilot and his armament. I readily concede the major credit to the pilot. I hope that he will allot a small measure of credit to his weapons, without relaxing in the least his insistent and proper demand for better armament.

The MIG-15 is armed with two 23-mm. guns and one 37-mm. gun, all three of which have relatively low cyclic rates of fire. The Russian 23-mm. gun fires at a cyclic rate of 700 to 800 rounds a minute, and the 37-mm. at 400 rounds a minute. The United States F-86 is armed with six caliber .50 M3 guns. The ratio of rounds fired per minute per plane is almost four to one in favor of the F-86.

The compound errors of the fire-control system, the aircraft gun mounting, the effect of temperature on bullet velocity, as well as the variation of bullet velocity with barrel life, render it mandatory that we depend upon the shotgun principle of hitting. When all these errors are eliminated or scientifically accounted for, we can adopt single-shot, large-caliber guns or rockets for air-to-air combat. I don't expect this to happen in the near future.

Colonel Studler is chief of the Small Arms Development Division, Research and Development Service, Ordnance Corps, U. S. Army.

Not Complacent

We have been accused by some of supplying "aërial slingshots" to our pilots. I must say that our little "Davids," with their caliber .50 slingshots, are doing a good job against "Goliath." We are not, however, complacent—nor do we intend to become complacent.

We recognized, ten years ago, that

the caliber .50 gun would some day become obsolescent. Its main effectiveness lay in the fact that enemy aircraft carried the means of their own destruction—gasoline. The caliber .50 incendiary bullet acted as the match to ignite this fuel. The ideal caliber was, then, the smallest match which would do the job.

Toward Larger Calibers

Aircraft designers have recognized this and are taking measures to protect their planes against the effects of incendiary ammunition. As a result, the trend in aircraft armament today is toward larger calibers and, recognizing the fire-control problems, toward higher cyclic rates.

In 1941 we adopted the 20-mm. Hispano-Suiza gun. During World War II we made over 200,000 of these weapons. The relative merits of performance of caliber .50 installations versus 20-mm. is a subject of debate wherever pilots meet. The Navy is as proud of its 20's as the Air Force is of its .50's. Each uses some of the other's favorite.

We all recognize that if fuel is rendered invulnerable to ignition by projectiles, neither caliber in its present form is ideal for the job required. New types are required to effect major structural damage. Development programs have been under way for some time to cover this contingency. In the next two years, new, high-cyclic-rate weapons firing powerful, high-blast ammunition will make their appearance.

These guns will be capable, by relatively minor changes, of firing several calibers of cartridges, thus permitting adjustment of caliber of ammunition to the task at hand. This I consider a major accomplishment.

A Flying Platform

A military plane has been, and still remains, in my opinion, a platform for the firing of guns and the dropping of bombs. Frequently, the plane designer and the pilot lose sight of this fact. With the increasing complexity of both the plane and the gun, it becomes of great importance that the designers of both these items come closer together than they have been.

All too frequently aircraft armament has been an afterthought. Planes and guns must be considered in the same relationship as guns and ammunition. One without the other is useless.

In addition to target effectiveness, reliability is an extremely important characteristic. Automatic-gun ammunition in the larger calibers must be made with that high degree of uniformity for which the small-arms ammunition industry was noted during World War II. For that reason, at the outbreak of the present Korean struggle, 20-mm. ammunition was reclassified by the Ordnance Corps as small-arms ammunition.

The problems of Ordnance and industry will become more complex as increases in caliber occur. We do not have, in the United States, commercial organizations similar to Oerlikon and Hispano-Suiza in Europe. These companies are capable of fabricating and assembling all components of the fuzed high-explosive round for guns of their own construction, thus insuring full coördination of all components.

The Ordnance Corps alone in the United States has the integrated personnel, facilities, and experience to turn out an aircraft gun-ammunition package; yet to do that job effectively, Ordnance requires and uses the personnel, facilities, and experience of universities, research foundations, and manufacturers.

In so far as aircraft weapons are concerned, Army Ordnance operates wholly on the basis of funds and requirements supplied by the using services. All too frequently these funds are tailored to the cost of the specific job at hand, leaving little or nothing for basic development. This can become a dangerous situation.

American industry in time of peace is peace-minded. It is not interested in gambling its funds on the development of weapons of war in the hope of getting rich on royalties. This leaves the responsibility of budgeting for basic development in the aircraft-armament field to the Navy and Air Force. This fact must be recognized when the Air Force and Navy allocate funds.

A.O.A. Can Help

The American Ordnance Association can be of help in solving many of the problems we face today. Good steel and aluminum cartridge cases are needed. Improved smokeless, flashless, and erosionless propellants are necessary. Lightness of weight in weapons is a basic consideration for aircraft.

In the past five years, aircraft ammunition has shifted from the percussion primer to the electric primer. We expect the A.O.A. to help us iron out some of the development and production problems we face as a result of that change.

We need and welcome the assistance of industry. With the assistance which industry assuredly will provide, I predict that the aircraft of the United States will remain the most effective and the most potent of any nation on earth.

Armed with six caliber .50 M3 guns, the North American F-86, above, has shown a 4 to 1 lead in ratio of rounds fired per minute per plane over the Russian MIG-15.

AIRCRAFT FIRE CONTROL

Faster Speeds and Higher Altitudes Demand More Complicated Equipment

Col. John F. Babcock

AIRCRAFT fire control consists of those radars, computers, servos, turrets, and fixed-weapons installations which, by controlling the fire of guns and rockets, seek to destroy the enemy.

I should like to review briefly the requirements for this fire control. We generally consider that these requirements are in two categories—equipments for offensive application (tactical support, maintenance of air superiority, etc.) and those required for defense of our own aircraft (or the industrial complex of this country). We place bombardment and interceptor aircraft fire control in this class.

Fire Control

Our fire control for interceptors must be capable of destroying intruders. It must provide capability to operate effectively against enemy aircraft at all hours of the day or night, in all types of weather, and at any altitude and speed selected by the enemy.

Few realize the magnitude by which higher speeds and altitudes increase the complexity of this problem. There are those who believe that, once the target is sighted, the difficulty of intercepting should not be much greater at a speed of 600 miles an hour than at a speed of 250 miles an hour since the relative speed of interceptors and enemy aircraft is the same.

Experience has proved that at the higher speeds interception presents a much more difficult problem, both from the standpoint of speed and altitude. Part of these differences are attributable to aircraft characteristics. Others stem from man's reaction time and the inability of the eye to search the sky and pick up targets at altitudes where no comparison is available. The task is further complicated by the requirement for all-weather operation and the fact that, should a pilot misjudge a given attack, the target will be miles away and probably cannot be brought under attack again. We are well into the region where the human pilot is no longer able to master these problems, and we must turn to automatic control from take-off through interception to landing.

Colonel Babcock is chief of the Armament Division, Office of the Director of Research and Development, United States Air Force, Washington, D.C.

This address was delivered at the Aircraft Armament Session of the Thirty-Third Annual Meeting of the American Ordnance Association, Cincinnati, Ohio, October 4, 1951.

Defensive Problems

Bomber defensive fire control must solve similar problems and, additionally, it must keep track of enemy interceptors, evaluate the relative danger of each, and lay guns on the most dangerous of the attacking aircraft. In addition, these systems must provide preventive countermeasures to reduce the effectiveness of the enemy interceptor radar.

Generally speaking, the fire-control systems required for the maintenance of air superiority present problems identical with those presented in interception, including the difficulty of interception at high altitudes, human reaction time, all-weather capability, high closure rate, and aircraft performance.

When attacking ground targets, the fire-control system has yet another problem to solve. It must cope with high closure rates against stationary or slow-moving targets. Add to this the fact that the target is usually small and that the attack is complicated by the low altitude from which it must be delivered.

Jets Effective

The effectiveness of the jet aircraft for attacking ground targets has been proved. However, increasing speeds require the weapons to be fired at longer ranges, particularly in a diving attack. Firing must also be done with greater accuracy since a small aiming error against a stationary target causes proportionately greater miss distances as the forward speed over the ground increases.

Longer-range accuracy also requires a reduction of the approximations used in computer design and the addition of more aërodynamic data to the fire-control solution. Excepting target recognition, the fire-control problems presented by ground-support missions have been largely solved, and jet aircraft have proved to be superior gun platforms.

The development of fire-control systems to meet the needs of which I have spoken is a long-term and expensive proposition. It requires the very best efforts that industry can apply. In the development of this equipment we must always be guided by the limitations of aircraft space that can be made available for installation of fire-control systems. We must also consider the maintenance problems which will be presented by these systems. It is one thing to maintain equipment in operable condition under controlled conditions and another to maintain this same equipment under the conditions which we must assume may confront us in another war.

Maintenance Problem

I should like to emphasize this maintenance problem. At the time we were receiving additional funds to accelerate our research and development program, a great many of the civilian members of the various committees of the Research and Development Board expressed a great deal of alarm regarding the ability of industry to absorb these additional dollars in productive research.

These fears were generated by the belief that there was a limited amount of electronics research talent in the country. There was no completely valid measurement whereby we might determine the percentage saturation of the electronics research potential, and, although many studies had been made, results thereof were in some measure conflicting. The military got the extra money and was successful in placing research contracts with industry. I would not say that in all cases we obtained maximum skill. We did, however, provide industry with a base on which they could expand their research facilities.

"In many cases we find that in the engineering of a piece of equipment too little attention is paid to the necessity for maintaining it under field conditions. . . . It will do us little good to construct a robot if we are unable to maintain him in workable condition."

Now we are beginning to get from industry the first trickle of what will become a steady flow of highly engineered and very specialized military equipment. As these equipments arrive at our field installations we will be faced with the task of maintaining them in operable condition. The question which troubles us a great deal involves our ability to provide the maintenance skills required.

In many cases we find that in the engineering of a piece of equipment too little attention is paid to the necessity for maintaining it under field conditions. Certainly it must be realized that the military, representing as it does a cross section of the population of this country, does not possess an overabundant supply of personnel with the necessary aptitudes.

I am concerned that, considering fire-control equipment, bombing systems, defense-net radars, navigation systems, IFF equipment, GCA, etc., and their increasing complexity, we may be creating logistical problems of considerable magnitude. I believe that all of us must pay more attention to this aspect of military operations. It will do us little good to construct a robot if we are unable to maintain him in workable condition.

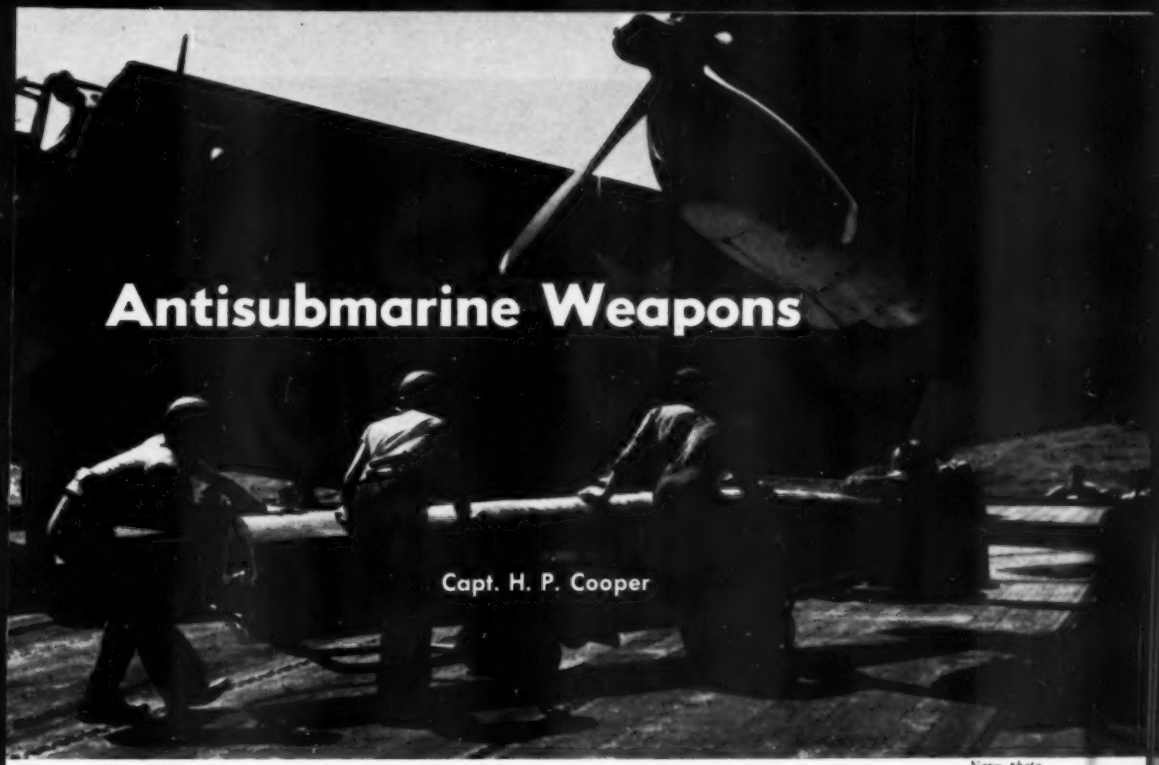
The development of these equipments is, in some respects, a considerable departure from the normal efforts of industry. Although it is true that industry designs and develops many complex items for use in the civilian economy, we must present it with problems which add further difficulties, both in design and in production.

A Big Job Ahead

American industry has proved, both in peace and war, that it has a capability of mass producing which is without parallel. The problem I propound today requires, in addition to this capability, the capacity for developing equipments superior to those which we may encounter. It is a big job, and it will require the efforts of the best research staffs for a long time. But it must be done, and I feel sure that it will be done.

"We must undertake to destroy any enemy bomber endeavoring to attack this country. Some enemy bombers probably will get through in any determined attack, but we must stop as many as humanly possible. We plan to do this by means of speedy interceptor aircraft, operating in conjunction with a vast radar net. The command that controls this force is known as the Air Defense Command.

"In addition, my own command, the Strategic Air Command, is prepared to strike enemy bomber installations and destroy as much as possible of that enemy's bomber force even before it can become airborne against us."—GEN. CURTIS E. LE MAY, *Commanding General, Strategic Air Command, U. S. Air Force.*



Antisubmarine Weapons

Capt. H. P. Cooper

Navy photo

New Developments Meet the Challenge of Undersea War

IT is quite common knowledge that at one stage of the last war, particularly during the year 1942, we were fighting a losing battle with enemy submarines. In early 1943 it was considered that an Allied victory was directly dependent on the battle of the Atlantic. The tide was finally turned because we were able to bring our then so-called "new" weapon—radar—and aircraft into play against a submarine that operated primarily on the surface and launched straight-running torpedoes.

Now, less than seven years later, we are faced with an entirely different problem and one with which we have little experience.

Problem Grave

The antisubmarine problem was never more grave. The development of the snorkel, the advent of high submerged speeds, and the introduction of the target-seeking torpedo have given the Navy a serious threat to overcome at an urgent priority.

Control of the Seas

Control of the seas today means control of the surface, of the air above it, and of the sea below the surface. The latter is the area that offers the most protection to the enemy and presents the greatest challenge to our sea defenses. It must not be forgotten that antisubmarine warfare involves all three of the aforesaid areas.

The hunt to kill the submarine commences within our continental harbors and inlets, includes the coastal areas, continues to the open sea, and is renewed in foreign areas under U. S. or Allied control.

Responsibility

As one of the material bureaus of the Navy, the Bureau of Ordnance is charged with the responsibility of designing, developing, procuring, manufacturing, and distributing weapons to the ships and aircraft produced by the Bureau of Ships and the Bureau of Aeronautics to combat the submarine effectively in either a surfaced or submerged condition, whether attacking at high submerged speed or lurking as did the notorious Nazi "wolf packs" of World War II.

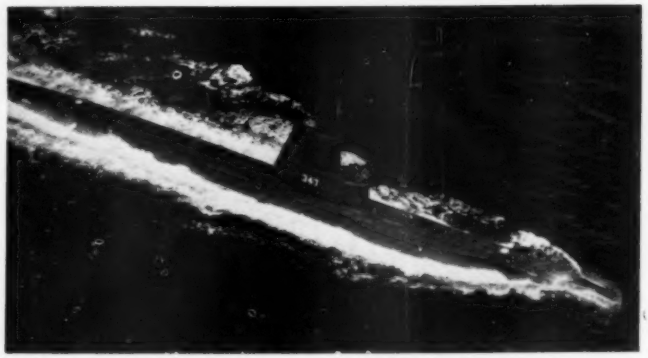
Weapons available to antisubmarine

Captain Cooper, Program Director for Aviation Ordnance, Planning and Progress Division, Navy Bureau of Ordnance, served during World War II on the staff of Adm. R. K. Turner, Commander of the Amphibious Force, Pacific. Captain Cooper later commanded the escort carrier U.S.S. BRETON and served as chief of staff of Carrier Division Five, Pacific Fleet.

This address was delivered at the Thirty-Third Annual Meeting of the American Ordnance Association, Cincinnati, Ohio, October 4, 1951.

forces include: guns, mines, nets and booms, projector charges, bombs, depth charges and depth bombs, torpedoes (aircraft, surface, and submarine-launched), rockets, and guided missiles.

The effectiveness of gunfire is obviously limited by the probability of the submarine being caught on the surface or surfacing after sustaining damage from underwater attack. However, gunfire must not be discounted as an effective and accurate weapon to be used when a surface engagement becomes imminent.



High-speed, snorkel-equipped submarines increase interception problems.

Commander's Decision

The decision as to which weapon to use to attack the hostile submarine rests with the tactical commander at the scene, but he must consider every weapon available to him and select the weapon or the combination of weapons that will meet the immediate situation and then use them effectively. It is the responsibility of the Bureau of Ordnance to insure that the latest and best developments of all types of weapons are available to the fleet commanders.

The Bureau of Ordnance antisubmarine program can be roughly divided into weapons systems for surface ships, aircraft, and antisubmarine subs; antisubmarine mines; and the passive type of defense gained from nets, booms, and controlled mines.

During World War II an ahead-thrown weapon, the hedgehog, was developed. By an ahead-thrown weapon I mean a mortar-type projector mount that fires a projectile charge equipped with a contact fuze.

The weapon was designed for submerged submarines and, although limited to a range under 1,000 yards, proved itself most effective. Depending upon the size of the vessel, one or two mounts can be carried. Both are normally located in the forward part of the ship, and from that fact the classification of "ahead-thrown weapon" is derived.

Weapon Modernized

The World War II weapon is being modernized in many ways. Features of train and stabilization have been incorporated, and increased range can be given by simply increasing the powder charge. This increased range will permit our antisubmarine ships to fire before losing sound contact. Other improvements being worked on are increased pattern, an improved fuze, and a greater sinking speed.

The old stand-by "ash-can" depth charge has certainly received considerable criticism in the past. However, this criticism was based on the types of depth charges and manner of control employed in the last war. A program is now under way to improve depth charges, depth-charge patterns, and attack equipment, all of which promise considerable improvement to this type of weapon as a supplementary means of attack.

New Intervolometer

A new type intervolometer is being developed that will permit the automatic laying of depth charges, including a modernized symmetrical pattern that will be forty to fifty per cent more effective than the World War II pattern. Hydrostatic fuzes are being developed that will give greater depth settings and increase the probability of kill.

Probably the greatest and most radical advance in underseas warfare has been the development of a new rocket launcher that will fire a large rocket containing several hundreds of pounds of explosive. The range will be in excess of 1,000 yards, and for the first time a surface-launched antisubmarine rocket will be controlled by a complete fire-control system.

This will give the firing ship the advantage of pin-point accuracy and thus force the submarine to remain at ranges greatly reducing the effectiveness of its torpedoes. Design of this system has been completed, and a few fleet ships are now equipped with this launcher.

Antisubmarine Weapon

The torpedo has been given considerable emphasis as a new type of antisubmarine weapon. It can be used from surface ships, submarines, aircraft, and the antisubmarine submarine. Our new torpedoes have greater range, higher speed, and greater explosive power, and some include homing features by acoustic methods.

By improved flight-gear development, aircraft torpedoes can now be launched at higher speeds and withstand the shock of water entry. Flight gear is the equipment necessary to slow the rate of fall of the torpedo. This is accomplished by parachutes that become disengaged at water entry.

Fire Control

One of our biggest deficiencies in antisubmarine surface ship equipment has been the lack of proper fire control. Detection and control is the problem of antisubmarine warfare. Weapons can only be effective if they are properly directed, trained, and detonated. The prime requirement of the fire-control problem is the establishment of a point of aim, which is range and bearing. Although we have had adequate and excellent fire-control equipment for naval guns since World War I, it has

only been a recent requirement to control rockets, hedgehogs, depth charges, and antisubmarine torpedoes.

An interim system has been in use by fleet units for about two years, and we now have a system for both surface ships and submarines that is successfully tied into the underwater sound-location systems to successfully pinpoint the submerged target and establish definite range, bearing, and relative-motion rates.

Automatic Plotter

In addition to control of the weapons, there will be an automatic plotter system that will plot the location of the target derived from four different sources. From information displayed on oscilloscopes and computers of the system it is also possible to plot on a chart a complete dead-reckoning picture of the target's course, speed, and depth, and the firing ship's course and speed.

In addition to their electronic detection and fire-control equipment, aircraft are provided with depth bombs, rockets, and torpedoes. Naturally, they are much lighter than surface and submarine type weapons, but they do carry approximately the same amount of explosive. This is possible because space normally required for engine and steering controls, as in torpedoes, can be made smaller because of the carrying vehicle's mobility. Mines must also be considered as valuable airborne weapons, but these will be discussed later.

Although a limited number of submarines have been caught on the surface in the past, it is doubtful that such would happen in the future due to the developments that have been accomplished in the latest submarine design field.

Depth Bomb

The first antisubmarine aircraft weapon I mentioned was the depth bomb. This is in fact an oversize depth charge such as is used on surface ships, except that it is streamlined for air usage. It is fired in the same manner as the standard depth charge. During World War II the depth bomb was used for a great many purposes and proved extremely effective even against ground forces because of its shell which gives great blast and fragmentation effect. No new developments are planned for this weapon because it has proved its usefulness and more effective weapons are being developed and produced.

There are two different types of torpedoes now available for service use. One is the straight-running torpedo of World War II, and the other is the target-seeking type. Under development are many variations of the target-seeking torpedo, and some of them are quite fantastic in their actions. They can be used by surface escort vessels, submarines, airplanes, blimps, or helicopters.

Evasion tactics by the submarine only

tend to improve the effectiveness of the acoustic system of the torpedo while non-evasion tactics by the submarine merely make the job easier.

In general, the target-seeking torpedo will probably prove to be the best antisubmarine weapon for our aircraft. Its effectiveness, of course, will depend greatly on the ability of the aircraft to detect enemy submarines by means of its sonobuoys and magnetic airborne detection equipment.

Sonobuoys are small acoustic receivers and radio transmitters packaged in a buoyant case that can be dropped by aircraft in the water near a suspected target and then convert acoustic energy into radio waves for transmission to the listening aircraft.

These sonobuoys are dropped in a prearranged expanding pattern. Any signal received from them by the aircraft is quickly evaluated by a skilled operator who in turn directs the plane to the submarine's location.

Lighter-than-air aircraft (LTA) and helicopters, in addition to being equipped with sonobuoys, can also be equipped with what is known as a "dunking sonar." This detection equipment is used while these types of craft hover and lower the device into the water to pick up underwater noises.

It was recently disclosed that a new type submarine will soon join the U. S. Fleet. Officially this vessel is to be known as an SSK, an antisubmarine submarine, which we hope will popularly be known as the "killer submarine." The primary rôle of this vessel in antisubmarine operations will be as radar and sono picket vessel, to be used in a barrier patrol in certain restricted waters.

This means that particular emphasis has been placed on its listening and long-range detection equipment. Of course, it will be equipped with submarine versions of the various types of fire control and torpedoes that I have previously discussed. Next to the atom sub, this is probably the closest development to the complete and perfect submersible.

Mines

Mines are probably the most used and effective of all underwater weapons. They pack a terrific wallop, and detonation can assure serious, if not lethal, damage to any submarine or surface ship that stumbles into their range. They are not particularly glamorous, but they really will do the job.

In the past, mining has been directed mainly against surface craft, but with the development of the various types of firing mechanisms that I have mentioned, it can be just as effective against submarines.

"Hunter-Killer Group"

The most potent threat against submarines, one that carries the "Sunday punch," is the "hunter-killer group." This group was conceived and developed during World War II to extend the air-surface antisubmarine operations into the ocean areas remote from Allied bases. Its mission is to seek out and destroy enemy subs. It is a combination consisting of a carrier, its embarked aircraft which carry the special antisubmarine equipment and weapons previously mentioned, and from four to six destroyers or destroyer escorts.

Although the results of the hunter-killer operations are very gratifying, the Navy is constantly endeavoring to improve the weapons and tactics used in antisubmarine warfare.

Signal Corps

A REPORT ON

Maj. Gen. E. L. Ford

Chief of Ordnance, United States Army

This address was delivered at the Industrial Preparedness Luncheon during the Thirty-Third Annual Meeting of the American Ordnance Association at the Netherland-Plaza, Cincinnati, on October 4, 1951.

SINCE its inception the A.O.A. has been very close to Ordnance, particularly in the technical fields of weapons development and manufacture. There is a wide gap between what comes out of the laboratories in the form of a new item of ordnance and, on the other hand, what must be done in the fields of production engineering to provide a finished design which can be produced economically in quantity.

Fine Contribution

The scientists and engineers of American industry, working with us through the organization of the Technical Committees of the American Ordnance Association, are making an outstanding contribution in the mobilization of our scientific and industrial capacity.

It is these committeemen who help make it possible to provide superior ordnance equipment in adequate quantities in the event our country must mobilize its resources for an all-out war. And this is no small part of Army Ordnance over-all objectives which include:

1. Producing and procuring new, modern ordnance matériel for the expanding Army, Navy, and Air Force;

2. Reconstituting our world-wide reserve stocks in storage and in the hands of troops;

3. Continuing and increasing our progressive research and development program, and

4. Getting industry into production on a broad base so it will be in a position to expand rapidly to meet our needs in a war mobilization.

Because the dollar is a measure of comparison that we all understand quite clearly, I can easily impress you with the size and scope of our job by telling you that, of a total defense budget of approximately sixty billion dollars for the current fiscal year, we in Ordnance will be doing fifteen billion dollars' worth of the work.

We already have made great strides under this program. Because of our industrial mobilization and our procurement planning of the past, we find ourselves today on a broad base of procurement and production, but we must continue this effort. We are putting into practice now the plans we have been working out for many years. The theoretical principles of yesterday are realities of today.

Principles Sound

These principles, incidentally, have proved to be good and sound in every respect, and much credit must go to those farsighted individuals, both military and industrial, who participated in their development since as long ago as the early 'twenties.

From the procurement districts to Korea

the Ordnance Corps is doing a splendid job

of providing and maintaining

the weapons our troops need

for victory and national security

ARMY ORDNANCE

We are doing business today with thousands of industrial plants all over the country through a system of decentralization to our procurement districts, which is an efficient plan, economical, and of mutual benefit to the contractors and ourselves.

The Best Method

The method of procuring through fourteen Ordnance districts in two world wars has shown that it is the best method for carrying out the tremendous responsibility assigned to Ordnance in this field which involves the expenditure of so many billions of the taxpayer's dollars.

In attempting to get the most for the taxpayer's dollar, and to protect his interests, our procurement procedures are carefully established and just as carefully controlled.

In our Ordnance districts we depend heavily upon the counsel of business leaders. In my opinion there is no segment of the Government which *seeks* to have the public looking over its shoulder as do the Ordnance districts.

Review Boards

We use boards of review to guide us—they are active boards, not rubber-stamp arrangements—and their zealous interest is a very real inspiration to all of us.

The actual participation of business, industry, and the public in district affairs contributes to the accomplishment of a better procurement job, with a minimum of direction from my headquarters in "far-away" Washington.

Our Ordnance procurement district offices will expand, their responsibilities will grow, personnel will be added, and expenditure of funds will mount. Our accomplishments will not be without difficulties, but we shall never lose sight of our objective of obtaining quality ordnance material with the greatest economy to the taxpayer.

Production of another kind, but nevertheless of quality ordnance, is being carried out with great economy in our Ordnance shops and depots in Japan. That production is an amazingly efficient rebuild job.

Would Exceed Capacity

The most emphatic way I can tell you of the accomplishment of those shops is to say we in the United States would not have automobiles, washing machines, TV sets, and other such items in the quantity and variety we enjoy today if it were not for the rebuild of World War II equipment now supporting the Korean fighting. Our factory capacity would be too much in demand for military production.

I saw much unserviceable—and when I say "unserviceable" I could well apply a few adjectives—ordnance equipment, mostly vehicles, gathered together from many areas and then rebuilt to "like-new" condition to keep them rolling and shooting on the battlefields of Korea.

Job Expanded

Our rebuild operations in Japan were just getting under way when the Korean fight started. Then with the great energy of our Ordnance people, supported by thousands of Japanese, the rebuild job was expanded to a round-the-clock basis, and equipment has been flowing ever since.

Many thousands of otherwise worthless trucks have been conditioned for Korea, resulting in the supply of vital equipment at a critical time, with comparatively little effect on our civilian economy and at an extremely low cost to the taxpayer.

Work Impressive

I'm sure that an inspection of these ordnance rebuild operations on trucks, trailers, tanks, and other combat vehicles, as well as small arms and artillery, would impress the production managers of any of the large corporations in this country.

The Real Test

The true test of this ordnance equipment is its fine performance on the field of battle. Ordnance officers and men in Korea are well organized to provide supply and maintenance to our combat troops, and combat leaders and troops have full confidence in their arms and equipment.

The superiority of our firepower is said to be one of the principal reasons for extremely high enemy casualties, and you will agree with me, I am sure, when I say we are willing to trade with the enemy—firepower for his destruction!

Your Job, Too

The men of the combat arms expect us to provide them with this firepower in the quantities they require. It is our job to live up to their expectations and requirements—and it is your job, too!

NAVY

Weapons for the Navy

The Bureau of Ordnance Solves New Production Problems

Rear Adm. M. F. Schoeffel

THE Bureau of Ordnance of the Navy began in August 1842 when the bureau organization of the Navy Department was initiated. Its first Chief was a granite-jawed Commodore Crane, for whom a big ammunition depot in Indiana is named.

Thirty-two Chiefs

In the intervening 109 years the Bureau has had 32 Chiefs, some of whom have won real fame. In the 1890's there was Admiral Sampson, later commander of our Atlantic Fleet in the decisive victory of Santiago during the Spanish War. In the late 1920's there was Admiral Leahy, who served throughout World War II as the President's senior military aide. Although the late Admiral Sherman was never Chief of the Bureau, he did serve in it in the mid-1930's when it was very small, and he was then its only aviator.

The Bureau ended the 1930's a comparatively small organization. The central staff in Washington consisted of about 200 people. The field organization was made up of four manufacturing plants and about a dozen ammunition depots of which only one was large and only that one was not immediately adjacent to salt water. We were strong in the quality of our engineering, but our scientific organization was almost nil.

In Good Shape

We came out of the war and the peacetime cutbacks with dozens of manufacturing plants in operation or reserve, with nine new big ammunition depots, four of which are deep in the interior of the continent, and with two of the largest and finest scientific laboratories in the Nation.

Today our field establishment comprises 68 stations of over 1,000,000 acres, with a plant account of about $1,192,000,000, served by 1,500 miles of railroads and manned by approximately 70,000 people. Our largest station, Inyokern, although by no means as big as White Sands, still exceeds the size of Rhode Island.

Of our officer personnel, only about fifty are on permanent ordnance duty. The remainder are primarily line officers who have taken a stiff postgraduate course in ordnance and thereafter have alternated between line operational duty and shore duty under the Bureau.

As to our civil personnel, it us our policy that high-grade engineering and scientific work can best be done by full-time engineers and scientists. We consider the place of the naval officer to be primarily in the assurance of the suitability of the ultimate matériel for use in service, and in the field of administration. Therefore, we make a very conscious effort to attract to our key technical positions civilians of the highest caliber, and then to hold them.

In the past year Congress entrusted to us about $1,800,000,000, and in this new fiscal year the sum will be about $2,000,000,000. Although this is only a fraction of the trust imposed in the Chief of Army Ordnance, yet it is a huge amount of the money of us taxpayers. I say "us" advisedly, for all the people of the Bureau, in uniform or out, are taxpayers just like you.

Admiral Schoeffel is Chief of the Bureau of Ordnance, United States Navy.

This address was delivered at the Industrial Preparedness Luncheon during the Thirty-Third Annual Meeting of the American Ordnance Association, Cincinnati, Ohio, October 4, 1951.

Breakdown of Funds

What is Uncle Sam getting for this money? Considered one way, much of the biggest slice is ammunition, bullets, rockets, bombs, torpedoes, mines. Considered another way, sixty per cent of our money value is for aircraft weapons, forty per cent for surface ships and submarines. Cut a third way, half of it is for new weapons developed since the war, half for repeats of the tried-and-true.

Our developmental funds are going preponderantly into three programs: first, air defense, which includes the armament of interceptor planes, guided missiles, and antiaircraft guns; secondly, antisubmarine warfare, which includes weapons for aircraft, surface ships, and submarines; and thirdly, air offensive operations.

Now, Production

For five years we have majored on research and development at the expense of production. Now our job is primarily production and bringing our new devices into service. In the next two or three years a flood of new weapons should reach the fleet. Ordnancewise, our Navy is going to get a manicure, a hair-do, and have its face lifted!

In administering the $1,800,000,000 that was given us in fiscal 1951, we had a very trying time. The money came in fits and starts, and most of our contracting, unlike that of Army Ordnance, is centralized in our Washington offices. Three quarters of a billion came on January 3rd, and we were required to obligate that in three months. A third of a billion came on the first of

June, and we were required to obligate that in a single month. I am vastly proud of the job done by our procurement people, about 400 all told, for they labored nights and weekends to place this money wisely in sound, businesslike contracts for the benefit of the Navy and the Nation.

Planned Programs

This was no helter-skelter job. The funds went into programs that had been worked out in advance, based on directives from the Chief of Naval Operations and the Joint Chiefs of Staff and coördinated clear across the board with the programs of the rest of the Navy and the other services by the Munitions Board.

The programs have all been based on the policies of spreading the base among several suppliers, of avoiding geographical concentration near strategic targets, and of setting up sufficient capacity to be able to meet the requirements of full mobilization, while always protecting us taxpayers on quality, price, and delivery.

I have just outlined a group of beautiful ideals which we have met substantially, but not one hundred per cent. For all but a few items of importance we now have at least two sources of supply, in some cases ten or fifteen. Our contracts contemplate meeting our immediate needs on a 40-hour work week so that, come mobilization, we can increase our output 2½ times by going to extra shifts.

Negotiated Contracts

To place the business and set up the capacity we have had to use negotiated contracts and finance facilities in a big way. There is a widespread misconception that a negotiated procurement is noncompetitive. Far from it. For instance, for a certain type of highly technical projectile fuze, we felt we needed eight suppliers. We had specific knowledge of the capabilities and financial soundness of fourteen companies. Each was called separately and privately and asked for a proposition which was kept confidential. Then followed a period of "Joe, can't you do better than that?" until finally the eight were selected.

In most cases, two or three were selected out of fifteen or twenty with whom negotiations had been carried on. Negotiation does *not* mean to us any absence of competition.

In fiscal 1951 we financed facilities in private plants to the tune of about $80,000,000. In fiscal 1952 it will be about the same. But we are not thereby giving favored concerns the means to strangle their competitors when the defense program is eventually completed.

Title to the facilities we furnish rests in the Government; unless leased from us, they may only be used for Government work. When the job is done we may either remove them or sell them to the user at cost minus normal depreciation.

Profits Limited

The user gets *no profit* on the facilities contract. He must make his money on the supply contract where profits are limited by redetermination, renegotiation, and the seven per cent limitation on a cost-plus-fixed fee.

In one aspect of our work, we feel we must strive for greater improvement, and that is the small-business aspect. At present the definition of a small business is one employing less than 500 people. It's a poor definition, but it's all we have today.

Using it, I find that only eighteen per cent of our dollars went to prime contracts with small business in 1951. In the negotiated contracts, which made up ninety-six per cent of our money, the proportion was even a little less. In advertised-bid contracts, two-thirds of our dollars went in prime contracts to the little fellow.

The picture is not as grim as it appears on the surface, since our field stations, which do about ten per cent of our business, deal primarily with small concerns, and our big primes placed about fifteen per cent of our dollars with small first-echelon subcontractors. Over-all, I figure we spent seventy cents with the big boys for every thirty cents with the little businessman.

Why did we not do better in the face of the oft-stated policy of the Government to give small business a fair share? First, I really don't know how big a share is fair. Secondly, there is the nature of much of our material; for a small company cannot build a Mark 35 torpedo or a Mark 56 fire-control system of adequate quality in a usable period of time. Thirdly, there is the pressure on our business force of doing five years' work in one, which made us require business to come to our centralized procurement staff in Washington.

Proportion Increased

What are we doing about it this year? We have determined to raise our proportion of prime contracts with small business. We are increasing our proportion of advertised bidding, even though I shudder at the administration involved in sending out as many as 800 proposals and considering 100 bids on a single procurement. This *has* happened.

We are cutting our proposals into small lots. We are beating the bushes with a motorcade of items for small business and by making each of our ordnance stations an information center on both prime and subcontract opportunities. Also, since certain major ordnance equipment calls for the specialized technical know-how available only in the larger industrial concerns, we are encouraging subcontracting by these companies.

Specialists Appointed

We recently asked seventy-five of our largest prime contractors to appoint small-business specialists to act as points of contacts for small companies looking for subcontracting work. The response has been most gratifying, with most of the companies having already appointed these specialists.

Battle Is the Pay-Off

This is a thumbnail report of what the Bureau of Ordnance of the Navy is and what it does with our taxes. Our job is weapons—good weapons. Remember that in war, battle is the pay-off and in battle plenty of good men with plenty of good weapons are what it takes to assure victory.

Boeing B-47A Stratojet in flight (Air Force photo)

Air Power and Research

Continuous Development Is Vital to Air Superiority

by

Maj. Gen. Fred. R. Dent, Jr.

We court disaster unless every facility for our technical superiority is effectively utilized now

THE United States Air Force readily concurs in the equation so aptly phrased by your own organization: "Superior aircraft plus superior ordnance equal superior air power." The factors of that equation, translated into terms of national security, call for a research and development program second to none; vigorous aircraft manufacturing and allied industries; and effective, wisely coördinated and executed mobilization plans and policies.

Research Basic

It is universally recognized that a continuous research and development program is basic to any plan for achieving and maintaining technical superiority in the air. Unfortunately, it has almost become a matter of national pride for Americans to believe that such technical superiority is their birthright.

Actually, we have no monopoly on technical brains. We do, however, have in this country the basic means for attaining this superiority through our research institutes, our laboratories, our industries, our universities, and outstanding associations such as yours. Today, the emphasis which must be placed on achieving and maintaining technical superiority is even more pronounced than during the last war. Each of us must utilize even more effectively all the means at our disposal to earn that superiority, or we court national disaster.

Urgency Recognized

The urgency of this problem was recognized by the Air Force in the establishment of its Air Research and Development Command as a separate command in April 1951.

This reorganization consolidated

nationwide Air Force research and development activities under one central agency. With it, we now have a framework within which all talent and thinking available—including manpower, money, facilities, and time—can be more readily integrated into research and development objectives.

Equipment Limited

Not too many years ago, when one spoke of the aircraft industry he referred to those companies engaged in the production of the aircraft structure, engines, and propellers. A limited amount of equipment was installed, but, in general, it amounted to nothing more than modified ground equipment not primarily designed for aircraft use.

Even in those rare cases in which the equipment was designed for aircraft utilization, the items were relatively simple and packaged in convenient boxes so that it was only necessary for the manufacturer to scatter them throughout the aircraft.

Conditions have changed tremendously. Our technical problems have pyramided. The airplane has become an almost unbelievably complicated system of electronic equipment. In many cases this equipment must be tailored specifically for individual airplanes and, in effect, become an integral part of it. In fact, we have reached the point where the development time required for this equipment often exceeds that needed for the development of the basic airplane.

Aircraft Armament

The field of aircraft armament is a clear-cut example. Virtually its entire history, with the exception of a few World War I vintage hand-held guns, ring-and-bead sights, and manual bomb releases, has been compressed into the past ten years. It is a varied, complex, and rapidly growing science which cuts across almost every technical field.

The armament expert now must have a knowledge of mechanics, electricity, electronics, optics, aërodynamics; ballistics, hydraulics, mathematics, and many other technical specialties. He also must understand the problems associated with Air Force tactics and strategy.

The simple cross hairs used for bombing runs in our early airplanes have given way to the modern bombing system which weighs approximately 1,700 pounds and contains up to some 300 vacuum tubes.

For example, in our latest jet bomber, the B-47, there are slightly more than forty miles of wires connecting the various electrical and electronic devices. This aircraft contains some 41,000 different kinds of parts, not including rivets and engine components, and well over 3.5 million engineering hours were included in the construction of the early models. World War II rivets for fastening the wing skin have no place in construction of the B-47. The new method for fastening is through 15,000 accurately machined holes, with countersunk high-shear rivets whose drive-expanded threaded shanks are held in place by ferrules.

Then, too, there is the matter of aircraft space. The advent of very thin wings has left little room to carry gasoline for our very thirsty jet engines. That in itself leads to a very comprehensive development program involving all components which compose an electronic circuit.

Yet, in our efforts to develop improved aircraft and equipment, we constantly must guard against permitting them to become so complicated that reliability is sacrificed. Our aircraft and equipment must not become so involved that we cannot readily train operators to use them or mechanics to maintain them.

Of paramount importance in our effort to reconcile research and development with ready industrial producibility is the element of *time*. I need not emphasize that there will be little or no time for this country to prepare itself after war has actually started.

General Dent is commanding general of the Wright Air Development Center, Air Research and Development Command.

This address was delivered at the Industrial Preparedness Luncheon during the Thirty-Third Annual Meeting of the American Ordnance Association, Cincinnati, Ohio, October 4, 1951.

Speed Essential

Our ability to achieve victory will depend on our ability to obtain from industry the most advanced weapons in the shortest possible time. Further, we look to industry to exercise caution in its developments for the services to insure that the articles are capable of production in large numbers in the event of war.

For our part, we are making every effort to integrate design engineering and production engineering into our program so that aircraft and related equipment will not require redesign for mass production.

By the same token, we are considering the availability of critical materials required for airframes, aircraft engines, and the many other items which must be mass produced.

Problem Difficult

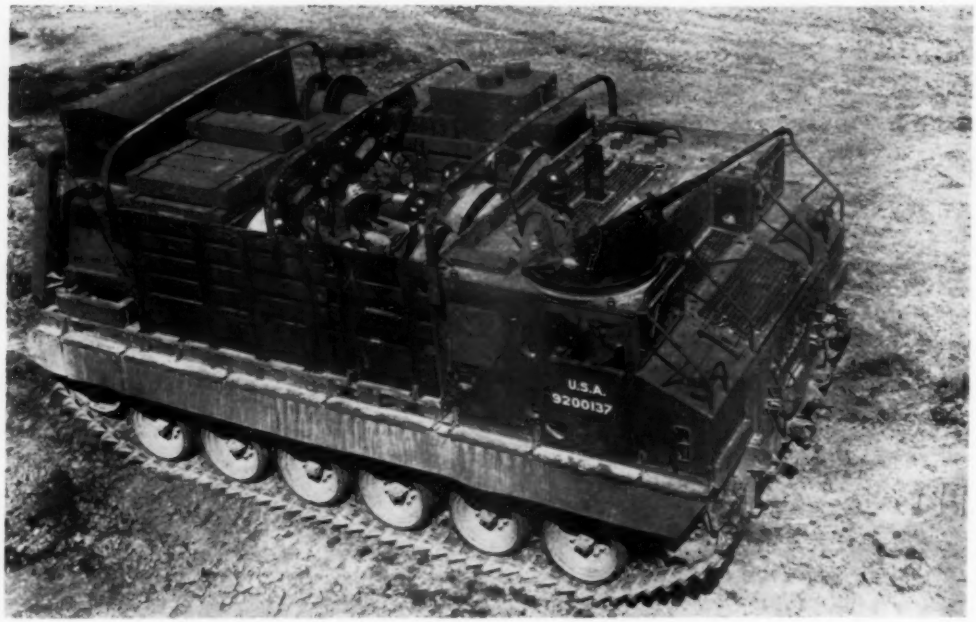
Our national problem is a difficult one. If it were possible to know the exact date on which our matériel will be needed, the building of a superior striking force would be a much less complex task. Unfortunately, this advantage rests with him who plans the offensive. We, therefore, must plan and prepare ourselves with a superior defensive and counterattacking force for use at any time.

We recognize, however, that aircraft problems cannot be disassociated from those of the over-all industrial-preparedness program. Aircraft and equipment production plans, of course, must be integrated with plans for tanks, trucks, ships, and other war matériel.

I know I speak for the Air Force as well as for myself in expressing appreciation for the contribution of the A.O.A. in advising and guiding the development of our industrial-preparedness policies and objectives.

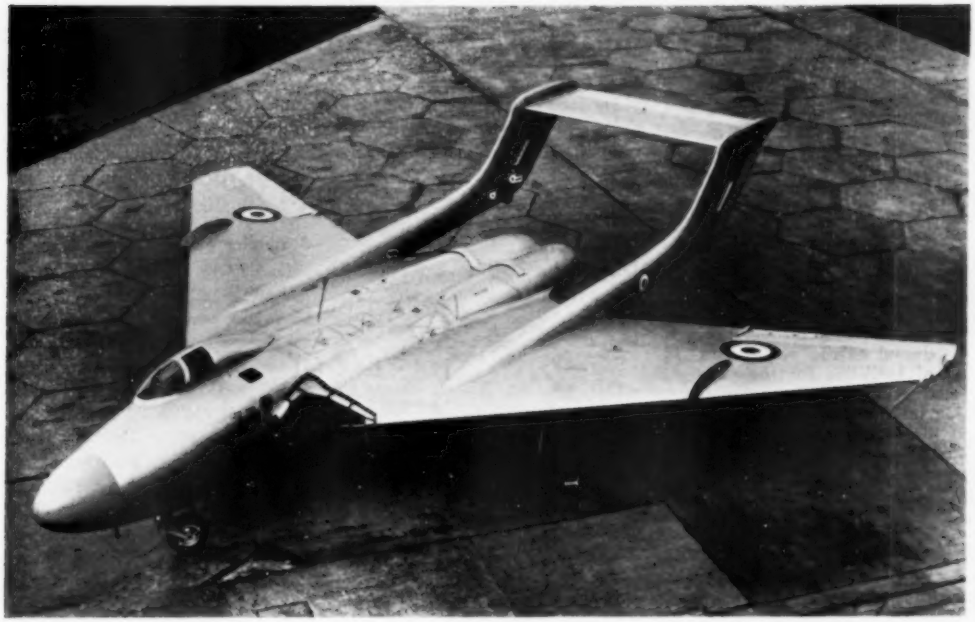
Your understanding of our problems and your untiring effort have done much to get us off to a good start in this crisis. Let us continue to pull together.

Recent Additions to Our Ground and Air Arsenals



The 22-ton Ordnance cargo tractor, above, is one of the Army's latest vehicles and can also be used as a prime mover, personnel carrier, bulldozer, or wrecker. It is armed with a caliber .50 machine gun (Army photo). The Navy's twin-jet F7U Cutlass fighter is shown below being catapulted from the deck of the U.S.S. MIDWAY during flight-evalution tests (Navy photo).

New Strength for Britain's Air and Sea Power



The twin-jet De Havilland day and night fighter, above, is one of an impressive array of British jet aircraft. Combining very high performance with modern electronic and combat aids, it is built on the twin-boom principle with sharply swept-back wings. Below is H.M.S. EAGLE, Britain's new 41,000-ton aircraft carrier which can mother 100 aircraft, including a jet squadron.

Blueprint for Preparedness

Dual-Purpose Plants Will Insure Industrial Readiness

by

C. E. Wilson

"We cannot afford either the time or money incidental to the acquisition of facilities for the production of military material each time a war or threat of war disturbs us."

IN his recently published memoirs Herbert Hoover said: "I came out of all my experiences in Europe [after World War I] with one absolute conviction. America with its skill in organization and the valor of its sons could win great wars, but it could not make lasting peace."

Unfortunately, his reasoned conclusions of more than thirty years ago seem to have been right, since he has lived to see not only a second victory in a world war, but also a second failure to achieve a stable peace. Only five short years after shooting stopped in the Second World War Americans are again fighting and dying far away from home. Some call the war in Korea a "police action."

Something New

It is something new in war, since the United Nations, while trying to stop aggression, are making every effort to restrict and confine the fighting. They are not using all their resources to vanquish their known enemies.

The free world still hopes that this action will not deteriorate into a third disastrous world war, but any thinking American must realize the possibility of such a disaster and the necessity of being prepared.

The form of government we have in the United States has been a great success, probably the most brilliant success in history. For many years our nation was small, remote, and poor, and what we did had little effect on the rest of the world. But in the last fifty years our Nation has achieved a position of great power in the world and with it a position of great responsibility.

Our type of government promotes the initiative of the millions, not the dictatorship of the few. It has produced an ideal environment for the rapid development of natural resources and the exploitation of marvelous new scientific discoveries and inventions.

Horsepower, Not Slaves

Americans, through the use of mechanical horsepower and machines, have substituted slaves of iron and steel for human backs, and through better organization and coöperation in the use of machines have accomplished much more with the same amount of human effort than have the people of any other country.

We have never been a military nation, but due to our great industrial development and the initiative and spirit of our people we can have great military power when we are forced to organize and use it. We have proved this in two world wars.

However, during most of the 175 years of our country's existence we have spent a relatively small amount of the Nation's wealth for arms or standing armies. This contributed importantly to the rapid development of the country, since the Nation did not continually have to carry such a nonproductive load.

Mr. Wilson, president of General Motors Corporation, delivered this address as the principal speaker at the Thirty-Third Annual Dinner Meeting of the American Ordnance Association held at the Netherland-Plaza Hotel, Cincinnati, Ohio, October 4, 1951.

A Smaller World

During the last fifty years, science and invention in the fields of transportation and communication have made the world relatively very much smaller. During the same period the increasing wealth and resources of our Nation have made our world responsibilities relatively greater.

Americans want peace, not war. They want peace with a stable economy and an ever-improving standard of living for all the people. The country was founded to promote the life, liberty, and pursuit of happiness of its citizens, not for the military or imperialistic aggrandizement of the Nation nor the development of superior power to be used aggressively to the detriment of others.

The problem that now confronts us is how best to promote world peace, maintain and preserve a strong and virile economy, and at the same time keep the Nation in a position to fight a war successfully in the event war is forced upon us.

Preserve Initiative

In solving this problem we must preserve the flexibility and initiative of our American free competitive society and must adhere to the principles that have made our country great. Only in this way will we be able to carry the defense burden in the immediate future without undermining our national economy. And if we are fortunate enough not to have another all-out war, we can soon again make rapid progress in improving the standard of living of all our people.

A defense program on a grand scale —and it must be on a relatively grand scale if it is to be effective—is a great load to be shouldered even by our

prosperous and industrious Nation. The years that such a program may be necessary are unknown.

Utilize Our Resources

There is an added reason, therefore, why we must utilize the resources of the Nation as efficiently as possible. We must have the maximum flexibility in our economy and industry so that we can devote a changing proportion of the Nation's effort to peace, preparation for war, or even all-out war, as conditions may dictate.

This requires a new kind of coöperation between industry and government, especially on the part of those established manufacturers who must assume the responsibility for prime contracts for the larger or highly technical military items that are now necessary to victory in war.

The current experience of General Motors Corporation in reëstablishing production of military equipment indicates that the country has not had an adequate or practical industrial-mobilization plan since the end of active war in 1945. The current emergency is again being met with emergency measures which are exorbitant in cost, disruptive to the civilian economy, and may not be adequate in time.

As long ago as the spring of 1945 and before the shooting had stopped in World War II, General Motors made the following statement in its report to shareholders for the year 1944:

"It has been well said time and again that we must win not only the war but the peace. The winning of the peace might be defined as the development of ways and means to insure over the years to come our economic, political, and personal freedoms. The elimination of armed conflict is fundamental in such a concept.

Learn from Experience

"How successfully that objective can be accomplished we do not know, but we must strive with all our power to that end. If we are to face the realities, and not take another chance on being caught 'too late with too little,' we must learn from present experience and reverse our prewar concept as to the importance of military preparedness. . .

• During the Thirty-Third Annual Dinner Meeting of the American Ordnance Association the Charles L. Harrison Medal for Distinguished Ordnance Service was awarded to Mr. Wilson by the Cincinnati Post of the Association. The medal was presented by Harvey C. Knowles, a vice-president of the A.O.A., and a director of the Cincinnati Post, and the citation below was read by Frederick V. Geier, also a Post director:

"Industrial leadership is a priceless American heritage. Such leadership when applied to the national defense of our country is beyond appraisal. Under Mr. Wilson's direction, General Motors Corporation, during World War II, produced armament on a scale of volume and diversity never before known in the history of our country. Not only in the great volume of production, but in many other phases, such as the training of our manpower in the operation and maintenance of military equipment, his leadership served the Nation well.

"To you, Charles Erwin Wilson, for your knowledge of design and your contribution to production methods of ordnance and matériel for the armed forces; for your determination and resourcefulness in overcoming difficulties in war production; for your leadership in undertaking a great share of the defense production load of the Nation; for your unfailing faith and striving to strengthen the national effort; for service which is indeed distinguished—

"We have the honor to present the Charles L. Harrison Medal, the Distinguished Service Award of the Cincinnati Post, American Ordnance Association."

"After the war, if we are to win the peace, we must continue to move forward by maintaining for preparedness equally close liaison between the armed services and industry. This calls for unceasing application of the day-to-day developments of science and industry to the improvement of war material and methods of manufacture, so that American industry shall ever be ready to set in motion quickly, if needed, its vast powers of mass production for war *with minimum changes in plant and machinery*. . .

"The cost of the war, in human life and also in material values, might have been importantly reduced and the war shortened if we had been better prepared."

Not War-Minded

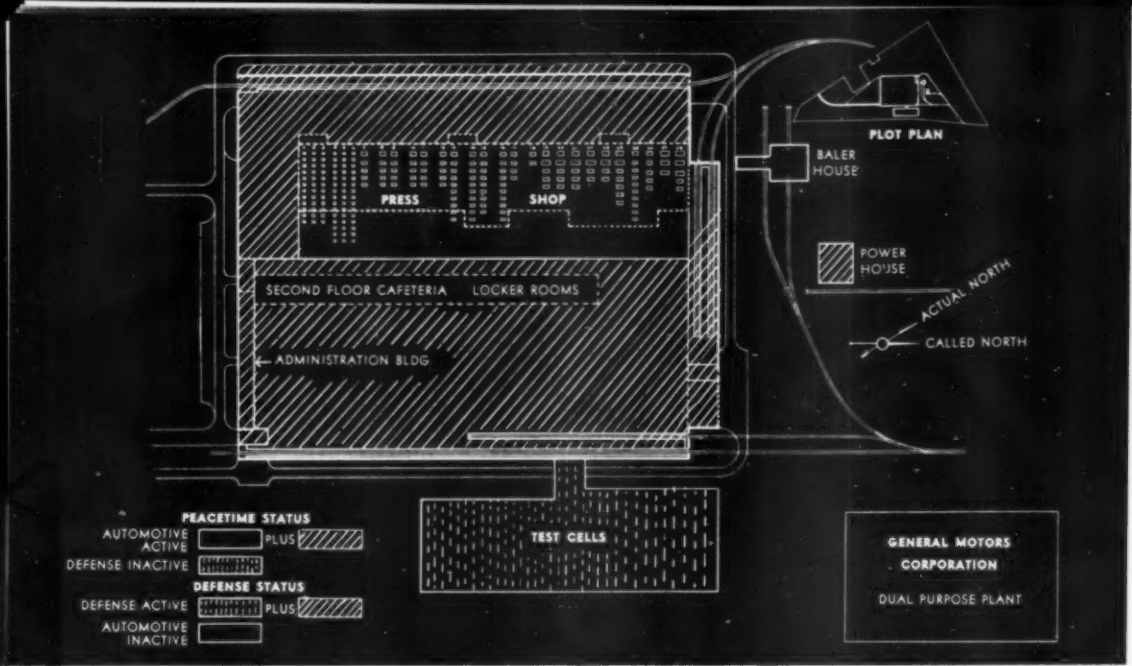
Americans are not war-minded. In the past we have not even felt the necessity for maintaining industrial and military preparedness. Therefore, some twelve years ago when we realized the possibility of becoming involved in a rapidly spreading war we were forced feverishly to construct new facilities for defense production and plan the conversion of our peacetime facilities to what would be required in all-out war.

Now, only six years after the shooting stopped in World War II, we again face the necessity of preparing our country to defend itself, but we find the special facilities constructed at great expense in the World War II period largely liquidated or converted to peacetime production. The country cannot afford to repeat this mistake. We must profit by our experience in World War II and what has happened since.

Plants Turned Back

Following World War II the facilities built for the account of the Government under the supervision of various manufacturers and operated by them on war work were promptly turned back to the Government when the shooting stopped. Hundreds of thousands of employees who worked in these plants were laid off. There was no definite plan for the use of the plants, the reëmployment of the workers, or recognition that such plants might again have to be used for production of military material.

The great majority did not share Mr. Hoover's conviction that "America . . . could not make lasting peace." In line with national policy, manufacturers converted their plants and facilities to peacetime production as quickly as possible. War production orders were canceled, and practically all military production stopped. Our peace-loving Nation turned from war and planning for war to peacetime pursuits. Americans acted as though world peace had been assured. . .



Floor plan of a dual-purpose plant for the production of jet engines and automobile body stampings. Solid areas would be usable for automotive manufacturing only; broken lines indicate parts usable for defense production only; diagonally lined parts of the plant could be used in the production of both the automobile body stampings and jet engines for aircraft.

Now world events have forced us to realize that for an indefinite number of years preparedness must be a continuing policy for Americans.

It is this matter of preparedness "with minimum changes in plant and machinery" that I want to emphasize particularly.

Integrate Capacity

If we must have an adequate and flexible mobilization plan for an indefinite period we must develop ways and means for integrating capacity for the production of military material with the production facilities required for the manufacture of consumer and producer goods normal to a peacetime economy.

We cannot afford either the time or money incidental to the acquisition of facilities for the production of military material each time a war or threat of war disturbs us.

I am proposing that manufacturers who are expected to assume responsibility for the production of the larger and highly technical military items be prepared to operate dual-purpose plants which can be used in three ways: For combined production, for total war production, or for total civilian production.

New plants now being constructed as part of the defense and essential civilian program should be constructed with this objective, and existing facilities, as they are partly changed to defense production, should be organized so that they are flexible for these same three purposes.

Definite agreements and understandings should be worked out by the Government, through its defense agencies, with these manufacturers for preserving the possibility of this type of dual operation for at least ten years and for renewing such agreements for several generations if necessary. It would appear to be time for this country to:

1. Decide that we need a permanent national-defense program;

2. Recognize that manufacturing industry is one of the major elements of such a program and must be kept prepared at all times to produce military equipment to the latest specifications and designs and, on short notice, in adequate quantities to meet full war requirements; and

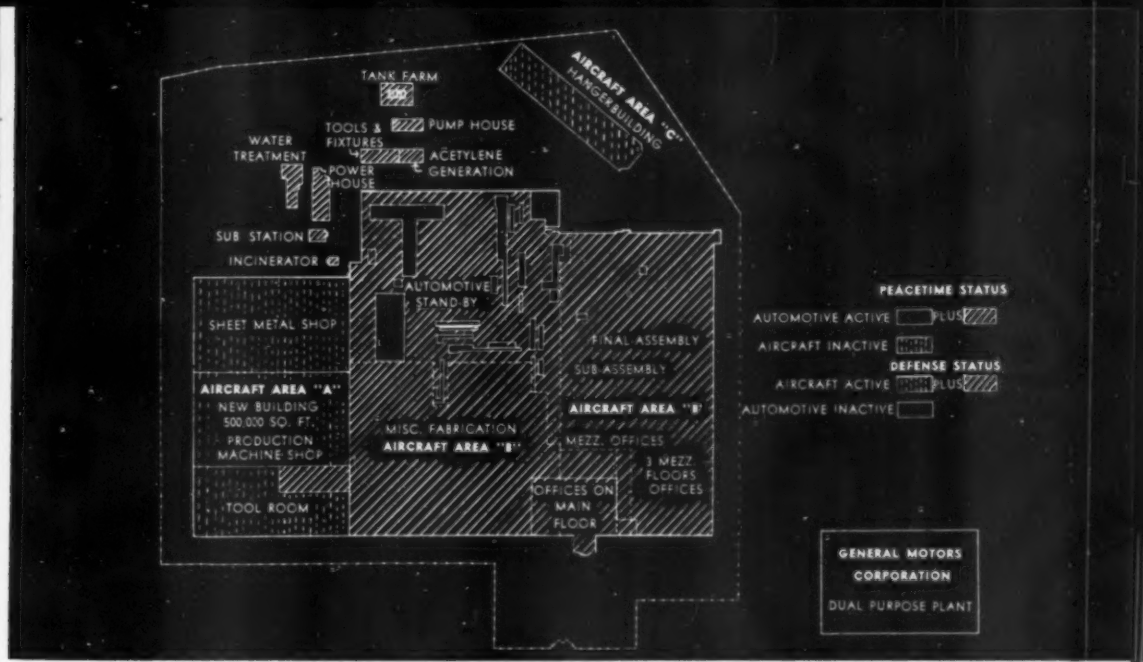
3. Provide legislation such as may be required to permit long-time contracts between the defense departments and industrial concerns for the custody and maintenance of such special or excess manufacturing facilities as may be required for war production and which also will permit to the extent possible utilization of dual-purpose plants and facilities at all times in the interests of maximum production and stable employment.

These points are not entirely new, and serious efforts have been made to accomplish in part some of these same objectives, particularly in the last few years. We now have a unified national defense establishment, a National Security Resources Board, a Munitions Board, and many other boards. Many patriotic citizens have accepted appointments in our defense establishment.

Much progress has been made, but the most fundamental and probably the most important element of a sound national-defense program has not yet been provided for.

Labor

The most important element in an adequate industrial defense plan must



This is the floor plan of a similar plant that could be used for the assembly of automobiles or airplanes. Solid areas show parts usable for automotive manufacture only; broken lines indicate the parts usable for aircraft production only; diagonally lined areas indicate parts that could be used in the assembly of both automobiles and of aircraft for the defense forces.

provide for the immediate employment of industrial labor with experienced supervision and management in its normal location and in a type of military production most closely associated with peacetime production. This can only be done through the medium of dual-purpose plants.

Since a good defense plan should also provide for maintaining commercial production at the maximum level possible at all times, we must be able to produce our normal defense requirements with a minimum of dislocation of commercial production, and we must be able to expand defense production to a considerable degree without totally eliminating commercial production.

Consumer Production

Even in the case of total war all consumer production cannot be stopped completely nor any of it for an indefinite period of time.

The difference in time required to meet an emergency with dual-purpose plants might well be more important than the final possible saving in cost.

It is essential that we also recognize that the time it takes to go to war is no longer the time it takes to train a soldier but rather the time it takes to produce his equipment and arms. Furthermore, we all know that stock-piling of equipment and arms is a doubtful defense measure because of the never-ceasing technical development of military equipment.

Effect on Facilities

Such technical developments would gradually affect production facilities but probably to no greater degree than commercial production facilities are being affected by technological progress, and it is important that improved manufacturing techniques be applied to production for peace or war. If America has to fight, we want the newest and most effective weapons for our fighting men.

There are some drawings here (see pp. 596 and 597) showing how a plant can be used for the production of jet engines and of automobile body stampings and what portions of the plant would have to be special for each purpose; also a drawing showing how a plant could be used to assemble airplanes and automobiles and the portions of the plant that would have to be special for each purpose.

Usable Areas

The drawings also clearly indicate the large percentage of the plant area that could be used for either or both purposes. Offices, cafeterias, locker rooms, hospitals, power plants, toolrooms, maintenance departments, railroad sidings, and parking lots can easily be identified as useful and necessary for both purposes. Certain parts of a dual-purpose plant, such as the space and equipment for testing jet engines can only be used when jet engines are being produced. Likewise, the space, foundations, and heavy presses used for making large stampings could be used only for automobile production.

But a large proportion of the manufacturing space could readily be made available for either purpose, and the necessary light equipment and assembly fixtures for either or both types of production could be quickly moved in and out of such areas.

Likewise, management employees, skilled employees, and production workers would be immediately avail-

able and could readily be transferred from one type of work to the other.

If such a dual-purpose plant were being used for all-out war production, the equipment special for the peacetime products could be stored in the area that had been laid out especially for the kind of machines and processing equipment that could not practically or possibly be converted to war production.

Storage Facilitated

Likewise, if the plant were used entirely for civilian production, the special equipment for jet engines or aircraft production could be stored in the hangars or in parts of the plants that were special for war production. Such plants could also be used for simultaneous production of both military and civilian items.

The job opportunities of the employees working in such plants would be reasonably protected. There would be no plants standing idle without competent custodians at times when they were not being used for war production. The ability to convert quickly to war production would be preserved. Of great importance, also, the properties could be quickly and flexibly converted back and forth from one purpose to the other without great expense.

During periods of limited defense production and as a part of the arrangement, the manufacturer who had such a dual-purpose plant would have the obligation of maintaining pilot lines if requested and of keeping up to date on engineering and processing of the military products he was scheduled to produce if a large military program again became necessary.

Dislocation of Workers

If instead of such dual-purpose plants, separate plants are planned—those producing war materials exclusively and those producing civilian products exclusively—there is bound to be dislocation of hundreds of thousands of workers as shifts are made from one type of production to the other.

Dual-purpose plants, while giving the Nation the security that would result from the ability to convert quickly from peace to war production, will at the same time put the emphasis on peace, not war. They will avoid the expense and waste of building and maintaining large plants planned only for war production.

They will avoid creating and maintaining organizations and businesses whose interests and profits would depend only on war production and of creating jobs for hundreds of thousands of employees whose job security would depend on war or the preparation for war. Such a plan for dual-purpose plants is consistent with our American objective of promoting world peace through strength and preparedness.

These dual-purpose plants should be operated and be a part of established industry. Our established industry constitutes a remarkably efficient system for producing goods, and our high standard of living attests to its effectiveness. This system is essentially an interdependent network of manufacturing concerns of all sizes—large, medium, and small. As a matter of fact, if it were not for our marvelous American industrial system, including the larger companies with their hundreds of thousands of employees and their mass-production accomplishments, we would not be confronted with this defense problem. Stalin or some other dictator already would be here.

System Works Well

World War II demonstrated that this system operates equally well when war material is being produced. In defense production the firms producing a finished product are prime contractors while those furnishing materials and parts are suppliers and subcontractors.

Prime contractors have the engineering and other experience necessary to plan the production and procurement of all the parts and materials required for the complete job. They also understand mass production, inspection, and quality control, and have the experience to use them effectively.

In particular, they have had experience in dealing with subcontractors and suppliers, and thus the individual production facilities and experience of these many firms can best be used.

The smaller manufacturers, and those who are usually referred to as subcontractors, normally will not have to go to the same length as the large primary contractors in providing for special facilities and dual-plant operation. Their efficiency as subcontractors depends on their continuing to use the equipment and know-how that they have used so effectively in their peacetime businesses. As a matter of fact, most of them are operating dual-purpose plants now.

Companies Open-Minded

Recognition on the part of industry that companies capable of making heavy or highly technical war materials will have to assume responsibility for doing their part in the defense or war effort should mean that such companies were open-minded to this dual-purpose plant idea.

A recognition on the part of the Government that dependence must be placed on such companies and their employees for efficient military production, especially in the event of an all-out war, should leave the Government open-minded in an effort to work out such a plan. I am sure that, if the people generally understand the dual-purpose plant idea, they will approve it.

I believe the suggestions I am making could be the nucleus of an industry preparedness plan that will be practical, workable, and sound for all concerned. I believe it will go a long way in providing for continuing preparedness at a cost which, with good management, the Nation can sustain. The success of the plan will, of course, depend on the full coöperation of every one.

A.O.A. Can Help

Obviously, we are faced with the necessity of developing some sound plan for maintaining industrial preparedness. Since promotion of industrial preparedness was one of the important purposes for which the American Ordnance Association was founded, it would seem to me that the Association could properly take up this dual-purpose plant idea and, by helping to establish it soundly and promptly, make a real contribution to our country.

Human Resources and Defense

Meeting the Increased Demand for Trained Engineers

by
R. E. Gillmor

"Among skilled people, the graduate engineer will probably become the most limited as well as the most essential to military strength and to the industrial and economic strength which provides the foundation for military strength."

According to published information, the Russians have a marked preponderance over the free world in numbers of troops and numbers of primary weapons—airplanes, tanks, submarines, small arms, artillery, guided missiles, and means for launching such missiles from land, sea, and air. They also probably have a high momentum in the production of these weapons and are therefore likely to maintain their preponderance for some time to come.

World Leader

Through a long series of events, the United States has become the leader in the struggle for individual freedom and dignity which has been the goal of mankind for many millenniums. As the leader we must compensate in quality of personnel and material for our inferiority in numbers. This will require, among other things, the most effective possible utilization of the limited number of people in our population with high orders of talent and skill.

Among these skilled people, the graduate engineer will probably become the most limited as well as the most essential to military strength and to the industrial and economic strength which provides the foundation for military strength.

The critically serious shortage of engineers that now exists has been made quite evident by surveys of the U. S. Department of Labor, the engineering societies, the engineering colleges, and the industrial associations. Because of unusually low engineering college entries in 1948, 1949, and 1950, the shortage will become steadily worse for the next three years.

Ratio Increasing

The statistics of the Department of Labor show that the ratio of engineers to other workers has been increasing steadily since 1890. The increased complexity of industry and the impact of new knowledge in areas such as atomic energy, electronics, automatic computation, jet propulsion, antibiotics, and many other fields have now resulted in a rapid upturn in the demand for engineers quite independently of mobilization.

Additional Demand

The impact of partial mobilization has superimposed an additional demand for engineers to apply the rapid growth of new knowledge to new developments in aircraft, ships, vehicles, weapons, instrumentation, equipment, and production facilities that are vital to national defense. There is every evidence that this demand will increase. The outcome of the growing world conflict might very probably hinge upon the relative effectiveness with which the two sides make use of their scientific and engineering talents.

Mr. Gillmor is vice-president of the Sperry Corporation. He is also a director of the American Ordnance Association.

More Training Needed

It might be argued that the output of engineers could be increased by shortening the length of college courses. With the increasing complexity of engineering, it is more likely that lengthening of the courses will become necessary. Because of this increasing complexity of new developments, the education and training of engineers must eventually parallel that required for doctors of medicine and surgery: first, a 4-year course culminating in a bachelor's degree; secondly, an internship of two or three years; and, eventually, a formal or informal postgraduate course in a particular field such as electronics, computing mechanisms, aircraft engine design, or some other specialty chosen by the individual.

Because the desirability of long training for engineers has not been fully recognized and because the shortage of engineers has only recently become generally known, the Reserve Officers' Training Corps enrolled many engineering students. Thus, many of the engineering colleges became auxiliary military academies for the training of officers.

Many Graduates Called

The rapid build-up of the military forces and the consequent need for officers has now resulted in calling many of these R.O.T.C. graduates. If the same thing had happened in the case of doctors of medicine, there would be an immediate recognition of the undesirability of using doctors in military service except as doctors.

There is enough evidence already at hand to show that the attitude toward the doctor is not paralleled by the attitude toward the engineer, notwithstanding the fact that the lives of our people will be as much dependent upon the engineer as upon the doctor.

Authority Will Be Given

Eventually this fundamental truth must be recognized. When it is, the technical and matériel branches of the military services will be given an authority over the disposition of reserve and draftee engineers commensurate with the responsibility which these branches have for the development, production, and performance of weapons, equipment, and supplies.

In both Government and industry it will be necessary to develop better methods for determining the special aptitudes of the individual engineer and in some cases to augment those aptitudes by postgraduate work or by special short courses such as those of the engineering, scientific, and management war training programs of the Second World War. Having determined the special aptitudes, it will be the responsibility of governmental and nongovernmental administration to make the best possible use of the aptitudes.

It will also become necessary to increase greatly the number of men and women who complement and supplement the engineer, thus increasing his effectiveness. This includes the designers, draftsmen, technicians, tool designers, toolmakers, test men, inspectors, and trouble shooters.

Should Not Waste Time

The engineer should be free to use his education and aptitudes to the best possible advantage and should not dissipate his time by doing anything that can be done by others. Several years will be required to remedy the shortage of experienced engineers. Competent supporting personnel can be developed in much less time.

The importance of maximum utilization of our human resources, and especially our engineers, makes it highly desirable that more study and effort be devoted to the improvement of the organization and administration of all our establishments whether they be public or private.

The rapid progress in science and technology has brought with it a rapid increase in specialization. It is a natural law, as true in the evolution of man-made organizations as in the evolution of life itself, that specialization is effective only to the extent that it is accompanied by coöperation. It is equally fundamental that the coöperation cannot approach a maximum except as a result of individual freedom with commensurate responsibility.

Good Organization

Good organization structure and good administration are essential to the attainment of coöperation through individual freedom and responsibility. Most of us know from our own experience how much more effective we are when we have a job which constitutes a challenge but is still within our powers; when we have no doubt as to what that job is; when we know to whom we are responsible and that he will trust and coöperate with us.

Decisions are usually the principal product of executives at all levels of any organization. A decision is most likely to be correct if it is made at the level where the problem arises and where the necessary time and facts are available. Widespread delegation of authority and responsibility for making decisions accompanied by adequate, above-board, and constructive inspection and reporting systems are symptomatic of good administration. Multiple levels of review of decisions are symptomatic of poor administration.

An important factor in the utilization of people which even the experienced administrator sometimes fails to take into account is the basic desire of the human individual for a sense of worthiness—dignity in the best sense of that word. For many centuries the laws of men have recognized that basic desire by drawing a sharp distinction between *malum in se* and *malum prohibitum*. *Malum in se* (bad in itself) includes all the offenses against the life and dignity of the human being. The penalties for such offenses have always been greater than those for offenses which are *malum prohibitum* (bad because prohibited).

Spiritual Evolution

In a book called "Human Destiny" an eminent biologist, DuNouy, developed the thesis that the only evolution of any consequence still continuing in this world is the spiritual and intellectual evolution of man. All other forms of life have either failed to adapt and have therefore ceased to exist or have become perfectly adapted and have therefore ceased to evolve.

DuNouy maintains that man's evolution is continuing because, through a long series of eliminations extending over hundreds of millions of years, man has become an extension of the Cosmic Intelligence and the only participant with that Intelligence on this planet in what can be called spiritual evolution.

He uses the word "spiritual" in its primary and most exact sense as including the intellectual, the aspirational, the faculty of thinking in the abstract, the faculty of coöperating with each other, and, in general, everything that is noncorporeal.

DuNouy says that fundamental evil is that which destroys the dignity of individual man, and fundamental good is that which contributes to his dignity as the only earthly participator with the Cosmic Intelligence in spiritual evolution.

Opposed by Communists

In their advance toward individual freedom and dignity the free nations are implacably opposed by the Communists. No one can tell how long this conflict of ideologies will keep us in a "bread and guns" economy. The Russians have their own inadequacies and fears, and as long as they are making progress on the economic, political, and psychological fronts it is unlikely that they will risk an all-out war on the military front.

The chances of postponing the struggle or of winning it if it comes depend upon our effectiveness in utilizing our own abilities and the abilities of all those for whom we are responsible or with whom we should coöperate.

The American System *and* Technology

J. Carlton Ward, Jr.

Leading aëronautical engineer, industrialist, and educator; member, board of advisers, Industrial College of the Armed Forces. This address was delivered before the students of the College.

IN the brief years between the First World War and the present time, great changes have taken place in the technique of warfare. Although it is not necessary to review these changes in detail, certain fundamentals should be noted to illustrate the tremendous scope of modern combat.

War is no longer carried on solely by uniformed personnel trained largely for physical combat and in the organization and supply of physical combat groups. Not so long ago Hitler put into operation what we now refer to as total war.

Total war involves all citizens in a very direct as well as an indirect way. Area bombing, bacteriological warfare, and atomic warfare all destroy indiscriminately and can be carried on far behind the lines of combat. In fact, this is the most effective theater of operations to destroy a nation's capacity and will to fight.

Three Phases

Total war assumes at least three phases: (1) political and psychological warfare, which may be the first phase, and it is a continuing one throughout; (2) economic warfare, the second phase and also a continuing one; and (3) combat war, which may be the last phase and actually may directly involve the fewest number of people.

By now we must all agree that the military and government official can not disassociate himself from all three phases of warfare, and his relation to them all must be an intelligent and a close one.

As Americans, we consciously utilize machines and devices in place of and to supplement manpower. We do this in both the combat front and on the home front; hence the prime importance of technology.

U. S. Production

This is an appropriate time to point out that as a nation we produce one-half of all the world's goods with only one-sixteenth of all the world's population. This is done solely by the appreciation of advanced technology.

For one segment of the world's population to exist in such an advanced stage of economy alongside regions and populations existing under a backward economy is in itself a subtle cause of warfare. Out of the tensions thus generated has come such new policies as the so-called "Point Four" of the present Administration's world program.

Humanitarians of the old school often cite the Age of Pericles of Greece as that of the golden age of mankind and, consequently, the most enlightened era. Fortunately that cannot be true for the reason that the seldom-described economy of that age was founded on human slavery and forced labor.

The use of animal power and of the toil of human beings was a substitute for the water power, the steam power, and the electrical power of our modern economy. As technologists, it is well to note in passing, that a human being can only continuously exert approximately one-twentieth of a horsepower for an hour at a time. In the United States today, power is available in the home and on the farm for approximately three cents per horsepower per hour—even in this age of inflation!

Thus today for one U.S. penny we can buy the power productivity of approximately seven ancient Greek slaves for one hour. A free American workman averaging $1.50 per hour, not including approximately 50 cents an hour in so-called "fringe benefits," earns enough to buy the power output of 1,000 Greek slaves of the so-called golden age of mankind.

It has often been said that America owes its high standards to its rich resources. Nothing could be more unfair. Greater resources exist in other areas of the world, and they largely remain undeveloped even in areas of much greater population density.

Others may say it is the climate in America that brings forth the energy and the enterprise of its people; still others say it is the result of the pioneering spirit of our early adventurous ancestors who left the security of the old world for the freedom of the new.

Reward of Freedom

The only proper conclusion is that our freedom, both political and economic, furnished the rewards and the incentives which cause our people, and caused our ancestors, to devote their energies to the development of their country's resources which in turn

brought about our breathtaking production-rich economy. This happy result, in turn, could only be accomplished by the employment of technology.

Manufacturer and Trader

In the early days of the Republic the Yankee became the great manufacturer and trader, simply because he used his native water power. He derived his knowledge of science and technology from Europe. Because of his racial origin he was familiar with the industrial revolution in England, and, since the appearance of Newcomen's steam engine of the late 1700's, he had learned about the advantages of harnessing steam for power, using coal as fuel.

Until the First World War, America continued to depend upon the great scientific institutions and scholars of Europe for basic scientific research. It was the great strain placed upon our World War I economy, when so many of the products of science which we had imported from Germany were cut off, that sparked our great development of applied industrial research and of research in the pure sciences. It was then that our industrial enterprises set out to organize for the first time their own integrated research laboratories.

It must not be forgotten, however, that, long before World War I, America had conceived of, and had pioneered, mass-production methods. It was early in the 1800's when small arms, a vital military need, brought these techniques into full flower.

First Mass Production

I would like to emphasize here that military needs were the midwife at the birth of interchangeable parts manufacture. It was thus that mass-production methods first came into general use in the United States and since then have spread to the rest of the world. Highly developed mass-production techniques still remain our specialty and are carried to their highest degree of perfection in this country. This technological development is one of the greatest assets for our national defense.

In theory, mass production is a technique whereby each operation is tooled for the production of completely interchangeable parts. It presupposes that the quantity to be produced allows for a high degree of tooling and for automatic inspection control. It further presupposes that enough parts are to be produced per day to allow one worker to carry on one operation continuously without the necessity for tear-downs and shift-overs.

In other words, each tool and each machine is specialized. Each is in continuous operation by one specialized worker who supervises the machine or process which is largely automatic in character. Lastly, the skill is built into the tooling rather than provided by the worker. As an example, a review of this definition will show that, in spite of many press releases and glowing advertisements to the contrary by proud manufacturers, there are no airplanes in true mass production—nor have there ever been any.

Military Needs Important

Now if we will summarize our remarks on the relation of production in America to technology, we will see that military needs under a defense economy have played a leading rôle in bringing into being the pioneering American concept of mass production and of production for interchangeability. Military needs have stressed the development of precision manufacturing in the modern sense, and this was brought into general use by the needs of World War I.

National dependence on our own resources under wartime conditions in the First World War led to the organization of research groups and of research activities both within and outside the industrial organizations in America. As a result, research activities became widespread in the United States after World War I.

True mass production, even in the high-production industries such as the automotive industry, is an ideal that is only partially achieved. The term frequently is loosely applied without a true understanding of its nature.

The American genius for production is a product of incentive and reward under one form of government. It can exist at a high level only under conditions of free enterprise, free labor, and free men—all free of totalitarian direction and regimentation. That it exists in a comparable degree in no other country of the world cannot be attributed to our climate, to our resources, or to our racial stock alone or in combination.

So far we have shown that high production follows the availability of power and of good precision tooling and advanced production methods. It must be recalled that they are all closely related parts of the same accomplishment. Thus while England pioneered in the use of power, particularly steam power, America adopted the concept almost immediately and quickly devised mass-production tooling.

Pioneer Engineers

Then through the work of the early American pioneers—Taylor, Gantt, Emerson, and their associates—there was created the art of production engineering, and thus was laid the basis for modern high-production methods and techniques.

But all the above would not suffice for our high-level economy without a continuing stream of better products. This is the field for technology in design and in invention. Early patent law was devised as an incentive for invention. It gave the inventor a limited-time monopoly as his incentive to create something new.

Military and government leaders are badly needed who understand this process, for invention is a risky business. There are not many who can do it, and incentive must be provided if it is to flourish. Bureaucrats have come dangerously close to destroying or badly impairing this flower of American genius by a failure to understand that invention is like art—it is a creative process, and it cannot be ordered into being. It must be encouraged—and that means rewarded.

Thomas A. Edison is the epitome of American inventiveness and is a symbol throughout the civilized world. There are, and there can be, no Thomas A. Edisons in Russia. He was a rugged individualist, as all who knew him or his achievements would attest.

However, Edison employed the cut-and-try method of an earlier age. While invention is frequently carried on today under like conditions, the atomic bombs, the modern airplanes, the rubber substitutes, the cellophanes,

the synthetic fibers and resins, radar, electronic systems, and the like, are not the products of individual effort using the cut-and-try system. They are, instead, the product of highly organized efforts to harness new science to new products and to new processes of manufacture.

German Origin

It is fair to say that this approach was not pioneered in America. Germany is often thought of as its origin in a modern sense. This was the lesson we learned in World War I when Germany had produced artificial indigo, artificial camphor (for gunpowder), coal-tar chemicals, synthetic drugs, optical glass, petroleum from coal, advanced metallurgy, artificial rubber, and a host of other great products from its organized research and its service teams. The German, French, and English universities provided the great graduate schools for scientists, and German industry supplied the large commercial laboratories which, taken in concert, produced such remarkable results.

Due to our inability to import, and to the defense requirements of World War I, great development also occurred in the United States. As a result, today we have the largest amount of research under way of any country in the world—an amount estimated at a billion dollars a year.

It is only proper to point out again that research, like invention, is a creative process, and it flourishes best in an atmosphere of freedom with incentive and not in an atmosphere of bureaucratic direction and control.

The record is clear on this point, and wise military and government leadership understands the sensitive relationship involved. Thus it provides and encourages the right climate for research to flourish in the civil economy where it is most fruitful.

Typical Example

The aircraft industry is an excellent and a typical example to illustrate the nature of the problem. In World War II it grew from an annual rate of output of $200,000,000 early in 1939 to $16,000,000,000 during 1944, the peak year.

"Long before World War I, America had conceived of, and had pioneered, mass-production methods. It was early in the 1800's when small arms, a vital military need, brought these techniques into full flower."

It grew from forty-fourth in size as an industry by U. S. census statistics, or halfway between the candy and the sausage industries, to the number one industry in the entire world. Despite predictions of leaders of the older war production industries that production would have to be done by others more experienced in the art, it nevertheless produced eighty-three per cent of all the American-built airplanes used in winning World War II.

However, the aëronautical industry's real genius lay in the improvement of its product. It was commonly said that by the time a design came off the drawing board for a new model of an airplane the model was already obsolete!

Here was an industry operating in a new science, aërodynamics (fluid mechanics), using new materials, such as aluminum and magnesium and their alloys, on a huge scale, with its products required to operate under a range of temperature and pressure changes never heretofore experienced and at speeds and altitudes beyond anything man had ever previously attained. Today the maximum airplane speed is not far from the rotational speed of the earth!

Yet the new aircraft industry not only turned out products to meet these conditions but also to meet the conditions of a newer form of warfare whose tactics changed from day to day, calling continually for new technical equipment, methods, and modifications.

It is well to review how this was done and what was learned as it applies to our subject. In the first place it became clear that only the military establishment could formulate the strategic and tactical requirements for the equipment. This became the raw material for the performance specifications.

Whenever the military authorities undertook to detail specifications for the specific construction and for the specific material applications, it encroached on the territory of the designers who alone had the responsibility for producing an article to meet the military needs as formulated in their performance specifications.

It thus became clear that the private contractor had this real responsibility. In turn, the military authorities had the sole responsibility for seeing that they received what had been ordered, and this led to their responsibility for evaluation of the product and for service testing.

Pattern Developed

This relationship, through experience, finally developed the following pattern that is hard to assail:

1. Fundamental research by the National Advisory Committee for Aëronautics, the National Bureau of Standards, American universities, and the like, largely supported by the Government;

2. Formulation of performance specifications by the military establishment from war plans and field experience and available research data;

3. Competitive development and production of prototypes and production articles by private industry;

4. Evaluation by military authorities at test fields and service testing under military use and direction.

That this pattern is successful can be measured by America's development of

air warfare on land and at sea and by America's gigantic aircraft production potential.

Designs Not Static

Time does not permit comparable discussion of other forms of material development and procurement by the other progressive industry teams working with the Army and the Navy, but it should be obvious that designs are no longer static for any of the various weapons and matériel. In this complex field of technology a lifetime career barely assures any individual of a potential competence in his specialty under the rapid scientific progress resulting from today's competitive world conditions.

Perhaps no better example can be used to show the importance of technology to civilization than that of the atomic-bomb development.

Before development was actively undertaken in 1940, word had been received that Drs. Hahn and Strassemann in Germany had experienced an inexplicable result when bombarding uranium with neutrons in the cyclotron in their German research laboratory. They gave out the results to all scientists in 1939, and almost immediately an Austrian physicist in asylum in Sweden and a British scientist in England advanced the theory of fission.

Theory Confirmed

The experiment was almost immediately duplicated in the Pupin Physics Laboratory at Columbia University and confirmed the conclusion that, in theory, a chain reaction was possible that would liberate energy several millions of times greater per unit of mass of material than chemical energy in any known explosives.

However, the vast research needed was apparent, and only the motive of national survival could have released the money, the manpower, and the facilities for such a task. So research proceeded on a small scale until word was received that our enemy, Germany, was proceeding full speed ahead and, if successful, would possess the means of dominating the rest of the world by force.

Then it was that the necessary funds were forthcoming under Presidential order and the Manhattan Project was born under the aëgis of the Army Corps of Engineers as a military project of top urgency.

History shows five years and approximately two billion dollars later the first bomb was successfully exploded. Thus we first possessed the world's most powerful weapon.

The bomb was the successful creation of the most scientific nation in the world—the nation with the greatest technical resources. American industry in nearly all segments was called upon to create and administer the vast facilities that fashioned the bomb. Even more astonishing than the creation of the bomb, a whole new body of science in physics, in chemistry, and in radiobiology came into being.

These new scientific developments in turn have made it possible to start construction of an atomic-propelled ship of hitherto unheard of characteristics and an airplane of fantastic performance, both in the military field. Most significantly, five projects are under way in the civil economy for the production of power in stationary plants.

"The American genius for production is a product of incentive and reward under one form of government. It can exist at a high level only under conditions of free enterprise, free labor, and free men."

In addition, the field of medicine has felt the impact of the use of radioactive isotopes in the study and cure of diseases to a point that is becoming revolutionary. In turn agriculture, geology, metallurgy, civil and mechanical engineering, and nearly all the applied sciences are finding new vistas opening up and more and more problems being solved for which no comparable solution had heretofore been possible.

Lastly, a new and fascinating science of radiation synthesis lies just over the threshold with vast unknown potentialities for the creation of new substances and materials.

In short, all civil as well as military endeavor is being radically changed as a result of the forced application of a new discovery in pure science under the impetus of military necessity.

What better example could be offered from the many examples of the close interrelation of technology and civilization than the case of new developments stemming from such advanced physical science which bids fair to change man himself and his worldly environment so radically and with so much promise.

Very few people are conscious of the fact that approximately six per cent of all the world's stored-up fuels—oil, gas, and coal—have been consumed in the last 150 years to support our power-consuming civilization. This process goes on at a rapidly accelerating rate, leaving the future of mankind and his civilization greatly in doubt.

Energy from Radiation

The new physical sciences have shown that practically all the earth's usable energy has come from radiation emanating from an atomic source, largely our sun. This radiation falls on our earth approximately 150 times as fast as the entire power needs of the world today. Since our fossil fuels are limited, we may guess that the sole answer to man's future life and civilization may lie in the new technology resulting from the military emphasis on the production and the design of an atomic bomb.

What better proof can be offered of the relation between technology and civilization and of the obvious corollary that a military or government leader of tomorrow must understand the significance of technology to the military art of war as well as in its relation to the civil economy. This includes his own country and also that of the rest of the world.

Finally, such a leader must know well the environment under which the civil economy will continue to be both healthy and productive. Otherwise he runs the risk of losing the world competition to his enemy and with it the destruction of his freedom, of his way of life, and that of all his countrymen as well as of all the citizens of other freedom-loving countries.

RESEARCH FOR DEFENSE

The Task of the Ordnance Committee of the Research and Development Board

by

Edwin F. Sweetser

The primary purpose of RDB in the field of ordnance is to guide military research and development in achieving and maintaining superior weapons

DURING the past year and a half, public interest has been engaged so completely by the military events in Korea that the various boards and committees working behind the scenes in the Department of Defense have received little attention.

The Research and Development Board (RDB) is such a group. Not much is known about its activities, partly because most of its work involves classified material. It is, however, an important cog in the machinery of national defense. I shall try in this article to describe the RDB and the way in which its work contributes to our national defense, particularly in the field of ordnance.

Popular Impression

Many people have acquired the impression that the Board's function is to generate the "fantastic new weapons" to which the press has so mysteriously alluded.

To the uninitiated, many of the weapons of modern warfare must seem fantastic. To the scientist and engineer, however, they are merely the embodiments and applications of scientific principles and techniques to accomplish a military task in the most effective manner.

Unfortunately, the urgent requirement for maintaining security deprives the public of early knowledge of many interesting new developments and causes considerable speculation, frequently erroneous, as to the nature of the work being done. Nevertheless, the RDB's rôle is extremely important, and its decisions can be expected to help shape the outcome of any war in which the United States might become engaged.

It is axiomatic that weapons have always played a decisive part in determining the outcome of wars. It was not until World War II, however, that weapons and strategy were so inseparably linked that technological developments were guided primarily by the requirements of military strategy and tactics.

Mr. Sweetser is executive director of the Committee on Ordnance of the Research and Development Board. He was formerly deputy director of the Board's Committee on Guided Missiles. Prior to that he was engaged at the Applied Physics Laboratory of the Johns Hopkins University on guided missiles. During World War II he served in the Navy Bureau of Aëronauties as a lieutenant commander on the design of airborne radar.

New Concept

During that war the Nation's scientific effort was effectively organized and executed by the Office of Scientific Research and Development (OSRD) under the inspired leadership of Dr. Vannevar Bush. This was a new concept designed to bring the country's best scientific and technical talent to bear in solving military problems. The success of this undertaking and its splendid achievements are well known and have been recorded elsewhere.

The OSRD, however, was not a permanent agency and began to terminate its activities shortly after the end of hostilities in Europe. In order to retain certain demonstrated advantages of the OSRD type of operation for the extensive postwar research and development programs of the War and Navy Departments, and in order to insure that the United States would continue to have a well-balanced program, Secretary of the Navy Forrestal and Secretary of War Patterson created the Joint Research and Development Board (JRDB), of which Dr. Bush became chairman.

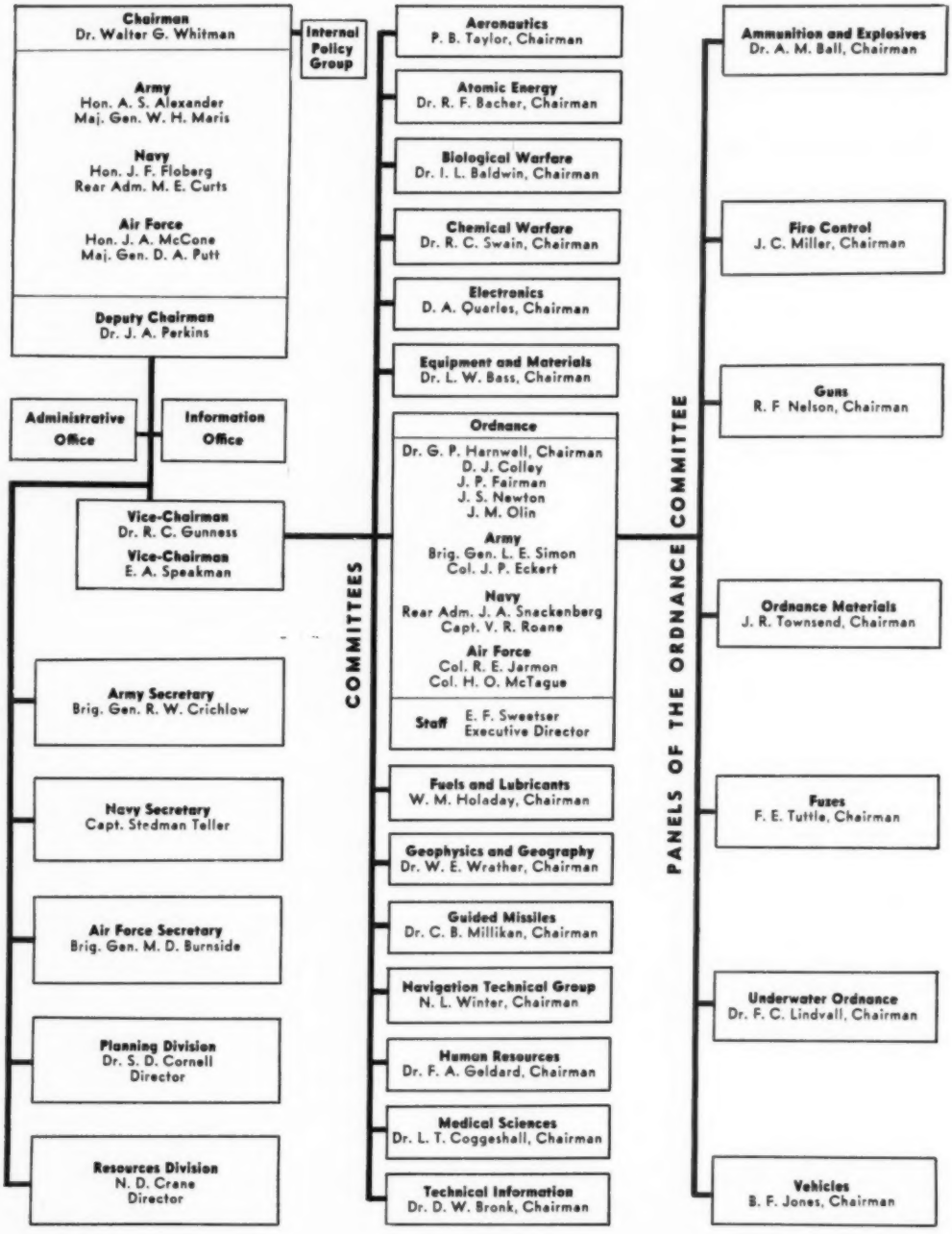
Board's Function

The function of this Board was to survey the research and development activities of the two Departments with the objective of filling gaps in the programs and, at the same time, eliminating undesirable duplication of effort.

When the Unification Act became law in the summer of 1947, the JRDB was legally reconstituted as the Research and Development Board, one of the four staff agencies reporting directly to the Secretary of Defense, the others being the Joint Chiefs of Staff, the Munitions Board, and the Armed Forces Policy Council.

The primary purpose of the Research and Development Board in the field of ordnance is to guide military research and development in achieving and maintaining weapons superiority. The Board has comparable responsibilities in the fields of psychological warfare, human resources, medical sciences, and other areas associated with

Research and Development Board
Department of Defense



increasing U. S. potential to wage war. Also of great concern to the Board is the development of effective countermeasures for probable enemy weapons systems.

Best Brains

In its 2,500 part- and full-time military and civilian personnel it combines the best available scientific and military thinking in order to insure the most effective expenditure of our 1.3-billion-dollar annual investment in research and development.

As a staff agency of the Department of Defense the RDB does not let contracts or administer research programs. These responsibilities reside in the military departments. However, the Board exercises advisory and supervisory powers which I will discuss later in more detail.

Briefly, the organization of the Board proper consists of a civilian chairman and two members from each of the three military departments. The chairman is appointed by the President and each member by the Secretary of his respective department. One of each department's representatives is the Under Secretary or Assistant Secretary responsible for research and development in his particular service, and the other is the general or admiral who directs the service's research and development activities.

This 7-man Board makes broad policy and program decisions affecting the Department of Defense research and development effort.

Committees Established

As a supporting structure to assist it in carrying out its functions the Board has established a number of committees in the many technical areas within its field of interest. Together with the Committee on Ordnance, with which we are most concerned here, there are committees on aëronautics, atomic energy, biological warfare, chemical warfare, electronics, equipment and materials, fuels and lubricants, guided missiles, human resources, medical sciences, technical information, and a technical group on navigation.

The committees and their supporting panels are made up of experts selected mainly from industry, the universities, and the military services, who serve on a part-time basis with occasional rotation of personnel to insure the continual flow of new ideas and fresh viewpoints while maintaining continuity.

Each committee is assisted by a full-time staff. The total RDB staff comprises about 300 civilian and military personnel serving on a full-time basis.

In addition to ordnance, the Research and Development Board is also interested in the fields of psychological warfare, human resources, medical sciences, and effective countermeasures for probable enemy weapons systems.

The committees have a primary function of supplying guidance to the military departments to assist them in strengthening their research and development programs. A particularly valuable product of the committees' activities is the provision of an effective forum for the fruitful exchange of information and ideas.

Plans Discussed

In the committee and panel meetings, representatives from the services, who actually administer the programs, report their plans and the progress of their work and discuss the problems with the civilian experts. The committees and panels thereby have an opportunity to talk over the way in which problems are being handled, to question plans, methods, and techniques, and to make recommendations and constructive criticisms.

The committee activities serve an additional purpose that is of very great potential value. This consists of maintaining an awareness and understanding of the military problems in a good cross section of our country's leading experts in the fields encompassed by the Board. If the present emergency becomes explosive, they will be much better prepared to devote themselves more completely to the military job than they would be without their experience with the Research and Development Board.

A short résumé of the activities of the RDB's Committee on Ordnance may be of particular interest to readers of this periodical. Research and development in the field of ordnance represents between 20 and 25 per cent of the total national program, or over 250 million dollars annually, the major portions of which are administered by the Army Ordnance Corps, the Navy Bureau of Ordnance, and the Air Force Research and Development Command.

Under the terms of its directive, which is similar in scope and intent to those of the other committees of the RDB, the fundamental objective of the Committee on Ordnance is broadly to coördinate, guide, and integrate the efforts of the military departments in seeking, through ordnance research and development, the best possible weapons and supporting systems for the armed forces of the United States.

The field of interest of the committee includes most of the weapons and related equipment used in warfare on land and sea and in the air, except atomic weapons and guided missiles. This includes over 2,000 projects whose diversity in many unrelated technical fields imposes difficult problems in committee administration.

To alleviate this situation the committee has divided its field among seven panels encompassing areas that are more homogeneous. These are: ammunition and explosives, fire control, fuzes, guns, ordnance materials, underwater ordnance, and vehicles.

A.O.A. Members Help

Each of these panels consists of a civilian chairman and one or more additional civilian members plus a member representing each of the military departments. Several of the civilian experts serving on the panels are also members of the Technical Committees of the American Ordnance Association. The committee is glad to have the resources of this excellent organization available as a source of competent and experienced ordnance experts to serve as consultants and replacements for members.

The function of the panels is to assess the adequacy of the individual programs and projects within their

fields, including the availability of technical personnel, facilities, and equipment; to determine whether there are gaps in the program, both in plan and in execution; and to seek to eliminate existing undesirable duplication.

Installations Visited

Periodically, the members of the committee and panels visit ordnance installations and contractors engaged in development throughout the country in order to acquaint themselves as fully as possible with work being done in the field.

A question that is frequently asked of RDB staff members is: "How does the Board go about determining the wisest possible use for the 1.3 billion dollars earmarked for military research and development?" Such an important decision must of necessity be based on year-round study and large stores of data.

Fundamental to the operations of the RDB is extensive and detailed knowledge of the research and development programs of the military departments.

One of the most important results of the project-reporting system, instituted by JRDB and still in use by the Board, has been to acquaint each of the services, and their bureaus, corps, and agencies, with what the others are doing in research and development. The Board provides a means of bringing this information together in one place and then seeing that it receives appropriate distribution among the services.

The primary purpose of the project-reporting system, to acquaint the RDB with the scope and nature of the programs, is served by a distribution of the project cards to the RDB committees, according to field of interest. The acquisition of project information is basically a one-time operation, but the information is kept current by means of progress reports, which the departments furnish to the RDB.

Two-Way Flow

The preparation of an integrated research program geared to military realities requires a 2-way flow of information between the Joint Chiefs of Staff (JCS) and the military departments on the one hand and the RDB and its committees on the other.

The RDB secures strategic guidance from the JCS as a basis for the preparation of a master plan for research and development. This guidance is in the form of information as to the relative strategic importance of various major types of military operations; for example, land combat, amphibious operations, and air-defense operations.

These main operational categories are subdivided by the Research and Development Board into technical objectives such as anti-aircraft weapons, submarine detection devices, radar, and others which support the operation. The individual projects then are grouped under the appropriate technical objective. When all this information has been compiled and arranged, with indications of relative priorities, it constitutes a blueprint for the Department of Defense program of military research and development.

Technical Estimates

The consolidated technical estimates are another important compilation of information. This information, prepared by the RDB, is designed to acquaint the Joint Chiefs of Staff with new weapons and significant improvements in the performance of existing weapons, weapons systems, techniques, and countermeasures that may be expected over specified periods of future time.

Its budget activity constitutes another important RDB responsibility. The first step in the preparation of the research and development budget is taken when the Secretary of Defense issues planning figures for the complete military budget to the departments. Shortly thereafter, the program guidance reports of the RDB committees are sent to the departments for use in connection with the preparation of the research and development budgets.

This guidance represents year-long studies by the committees of the departmental programs within their respective fields. The reports contain factual information on the nature and extent of the programs and recommendations regarding gaps that should be filled or shifts in emphasis that would be desirable. The Departments then forward to RDB for review their budget estimates based on their requirements, the information furnished them by RDB, and on the planning figures of the Secretary of Defense.

The Board's final approved budget recommendations are transmitted to the Secretary of Defense and, concurrently, to the departments. This enables the departments to adjust their estimates to conform with Board recommendations.

Close Liaison

I have already spoken of the close liaison maintained between the RDB and the departments and Joint Chiefs of Staff. Two other agencies of the Department of Defense that contribute a great deal to our operations are the Weapons Systems Evaluation Group (WSEG) and the Munitions Board.

The WSEG, sponsored jointly by the JCS and the RDB, reports directly to both agencies. Its function is to perform operations research in certain broad areas, such as land combat.

The Munitions Board advises the RDB concerning military production plans and furnishes information on materials in short supply. The RDB in turn relays to the Munitions Board pertinent information about developments which may result in heavy new production demands for critical materials or may result in alleviation of critical materials shortages.

Problem Immense

I hope that I have not implied that the whole of the RDB's task has been perfectly accomplished. This is far from being the case. The problem is an immense one, and one which requires the concerted efforts of the Board, the military departments, and the best civilian advice obtainable. The departments are coöperating splendidly, and we believe that real progress has been made. We look forward with enthusiasm to a great deal more progress in the future.

Month by Month: High Lights of the National Defense

No Magic Weapons

Shortly after he became Secretary of Defense, Robert A. Lovett warned the Nation that "there is no new, inexpensive, or magic way to win wars in the near future."

He emphasized the fact that, despite advances in weapons development and reports of atomic-energy progress, which hold great promise for the future, "our national safety in the face of attack depends upon the proved conventional weapons, in ample quantity, and with sufficient trained and equipped ground, naval, and air forces to use them effectively."

Startling publicity concerning "fantastic" new weapons caused widespread speculation that the Department of Defense might be able to reduce the strength and cost of the armed forces.

Secretary Lovett acknowledged that there is enough truth in research and development progress "to encourage a very optimistic outlook for improved American armaments," but he stressed the fact that "meanwhile, we must rely upon proved, tested, and available methods to win today's battles with the men presently trained to use them."

The Defense Secretary declared that aircraft, now and for some time in the future, will still represent the most efficient method of delivery of atom bombs.

"For that reason," he said, "the Department of Defense has indicated a need for appropriate increase in our national air power and its supporting forces."

Moral Standards

A four-point program for "protection and further development of moral standards" in the Navy and Marine Corps has been initiated by the Chief of Naval Personnel and the Commandant of the Marine Corps.

The program envisions strengthening the moral, spiritual, and religious lives of the personnel of both services. Commanders in every echelon have been directed to advance the program in their commands by:

1. Insuring that all personnel are reached by group instruction and personal interview on matters that promote realization and development of moral, spiritual, and religious values.

2. Taking a personal interest in off-duty activities of personnel and insuring availability of a well-rounded program of religious, educational, and recreational activities.

3. Insuring conformation to established moral standards in entertainment presented, activities of officers' and enlisted men's clubs, and contents of ship, station, and post newspapers, and other publications sold or circulated within their commands.

4. Coöperating with civilian and military agencies which contribute to the moral and social well-being of personnel.

The Bureau of Personnel said that chaplains will be key figures in implementing the program. Other staff members, including special services, welfare and recreation, medical, information and education officers, will contribute to the program.

Ordnance Research

Dr. Gaylord P. Harnwell, chairman of the Department of Physics and director of the Randall Morgan Laboratory of Physics at the University of Pennsylvania, has been appointed chairman of the Committee on Ordnance of the Research and Development Board, Department of Defense.

The appointment, effective November 1, 1951, was announced by Walter G. Whitman, Chairman of the Board.

Dr. Harnwell has been associated with military research and development since 1941. He has served with the Research and Development Board as a member of the Committee on Basic Physical Sciences and as chairman of that committee's panel on physics and mathematics. He has been a member of the Committee on Ordnance for the past year. He has also been vice-chairman of the National Research Council's Committee on Underseas Warfare.

During World War II, Dr. Harnwell was a member of the Division on Subsurface Warfare of the Office of Scientific Research and Development. He served also as director of the University of California Division of War Research, U. S. Navy Radio and Sound Laboratory, San Diego, Calif.

NATO Rifle Dispute

Prime Minister Churchill has decided to postpone, for the immediate present, the adoption by the British of their new caliber .280 rifle. This decision is of very great importance to the combat efficiency of North Atlantic Treaty Organization forces now being developed under the leadership of General Eisenhower. The introduction of the British rifle into these forces would cause serious complications.

The English weapon may be as efficient and accurate as its proponents claim it to be. But its adoption would certainly slow up the rearmament program and vastly complicate the ammunition supply and the interchangeability of weapons. These points are admirably emphasized by Colonel Mettler, in his article on page 664 of this issue of ORDNANCE.

The American small-arms program is based on the caliber .30 M1 (Garand) which has been in combat use long enough to have demonstrated its unique capabilities. It was adopted after competition with the smaller bore rifles similar to the new British development. We have factories in a position today to produce the M1 in great quantities and quickly.

Another important consideration is the fact that the M1 is not only a single weapon but the basis of a family of weapons, some in use and others in the development stages. These include the rifle grenade launcher, the sniperscope, the carbine, and modifications permitting the efficient use of the weapon under special conditions of weather and terrain.

Under these circumstances it is clear that the earlier British suggestion that we switch to their new smaller caliber weapon would be highly impracticable.

Mr. Churchill was quick to see these points and informed the House of Commons that "it would not be possible to rearm the British forces with the .280 rifle on the scale of the millions required for a considerable number of years." He added that "a few weeks can therefore safely be allowed for examination of this question at the present time."

The Prime Minister promised to give a full statement of his views at a later date. It is to be hoped that he will put an end to this disagreement between the Allies and present a plan for the closer integration of weapons rather than bring about a serious divergence that would be created by the proposed adoption of the .280 rifle.

Mr. Churchill's decision to postpone a verdict on the issue may have been influenced by a new series of week-long firing tests at Aberdeen Proving Ground, Md., where an Atlantic Pact board of rifle experts split three to one against the British rifle. American, Canadian, and French experts, weighing all factors, are reported to have expressed a preference for the American rifle.

A press announcement that sizable orders have been placed with International Harvester Company for production of our M1 rifle looks like our mind is made up—regardless of all the talk here and abroad!

Tactical Use of A-Bomb

The most important lessons that scientists and troops learned from the series of atom tests at Yucca Flat in Nevada were that the A-bomb could be adapted successfully for tactical purposes and that troops, properly trained and protected, could survive a nuclear blast.

The tests dispelled the widespread but erroneous belief that residual radioactivity would kill living matter in the immediate area of the atomic explosion. Army troops marched through the blast zone minutes after the detonation of a bomb without suffering any harmful effects.

Prior to the explosion, soldiers prepared typical battalion defensive positions—foxholes, barbed wire, machine-gun and recoilless-rifle emplacements, artillery positions, even communications switchboards. All the normal equipment used by a battalion was included.

Near the area where the bomb was to be exploded were tanks, planes, jeeps, guns, and individual equipment. Live sheep were tied to positions which would normally be occupied by troops under actual battlefield conditions.

According to an Army report, soldiers were drawn back about seven miles from the point of ground-zero. When the A-bomb plane was sighted, troops were ordered to face the opposite direction from ground-zero in order to avoid temporary blindness from the initial blast. Shortly after the explosion occurred, more than 5,000 men turned around again and witnessed the remainder of the awesome spectacle.

Immediately after the blast, an Army helicopter equipped with testing instruments headed for the site of the bomb blast. The road to the blast center was soon choked with evaluation teams with instruments for checking the degree of radioactivity in the atmosphere.

The soldiers quickly realized that they were in no danger from radioactivity. They could attack through such a blasted area in combat just as they were driving through it on Yucca Flat. There was no danger.

Two miles from ground-zero, the terrible effects of the explosion began to become apparent. Had there been buildings in the area, they would have been demolished.

Much closer to ground-zero, vehicles and other equipment under cover were examined. They showed the effects of burns, but damage was only moderate. They still could have been used.

No human being above ground could have lived in the first few seconds after the explosion. But below ground, or in pillboxes, the sheep were alive and unharmed. Soldiers in similar positions also would have been safe.

Exercise Desert Rock proved that the atomic bomb can be highly effective in ground warfare but that the value of infantrymen has not changed. Properly trained, they can survive an atomic blast and still accomplish their mission.

Canadian Arms Purchases

Max Mackenzie, Canada's Deputy Minister of Defense Production, recently announced that the United States was planning a big expansion in Canadian arms purchases.

He also disclosed that two major barriers to increased arms production for the United States had now been partly overcome. These were high American tariffs on Canadian-manufactured armament and the Buy American Act of 1934 which limited the amount of armament our fighting forces could buy from Canada and other countries. Mr. Mackenzie disclosed specifically:

1. An order placed by the United States for forty T36A Beechcraft planes, to be produced by Canadair, Ltd., of Montreal, is to be "considerably increased" when production starts.

2. An initial order for 109 Beaver aircraft, under production at the De Havilland plant in Toronto, is to be doubled soon and to be followed up with "further orders for even larger numbers."

3. Similar expansion in United States contracts will be developed for such equipment as the 3-inch naval guns under production at Sorel Industries, Sorel, Quebec, and Harvard trainer aircraft at the Canadian Car &

Foundry Company plant at Fort Williams, Ontario.

> *Making public figures that were hitherto secret, Mr. Mackenzie estimated that over a 15-month period the Canadian Government had placed $500,000,000 worth of contracts in the United States. The United States Government's orders in Canada amounted to only $95,000,000.*

He supported the view that Canada must take a greater part in the United States defense program if she was to make the fullest use of her productive capacity "and if we are to reduce the gap in our international balance of payments."

Another Canadian defense leader, Dr. O. M. Solandt, Chairman of the Defense Research Board, recently stated that this organization now has a staff of more than 1,600 and operates nearly a dozen research establishments scattered from Halifax to Victoria and from Toronto in the south to Churchill in the north. The total budget of the board for the fiscal year 1951-1952 is about $35,000,000.

The board is developing a new guided missile and a new infantry anti-tank weapon. Work is proceeding on the design of a howitzer for mountain warfare. The board is also interested in antisubmarine problems and in the field of electronics.

Hush-Hush in Reverse

The Army has finally let it be known how classified documents of World War II, many of which should never have been classified in the first place, are now being carefully screened for declassification to help industrialists, historians, researchers, and the press—before they become too feeble to care.

> *The Security Classification Review Branch in the Office of the Adjutant General, established in April 1946, has processed about 5,964 linear feet of files, and 87 per cent of the material has been declassified.*

A total of 28,228,075 classified documents—66,419 linear feet of material—have been scheduled for review.

We regret to say that the Army is still secretive about whether the normal six carbon copies to each original document are included, or excluded, in the linear measurements. It would appear that a great many classified World War II documents should be segregated by the ton and that a shovel would be a far more useful measuring instrument than a ruler.

Developments Aloft

The United States Army will acquire three new types of radical aircraft to move men and supplies by air within combat zones.

> *Combat planes are not involved. The craft being developed, which eventually may be bought by the thousands, will be integral equipment of armies, corps, and smaller units, just as land vehicles are. The three new aircraft are:*

1. A "fleep"—a flying automobile that some day may be as popular as the jeep. It is based on the civilian "airphibian" which Robert Fulton of Connecticut introduced after World War II.

The "fleep" will be a single-engine, closed-cabin machine with wings that can be mounted or taken off, without tools, in five to seven minutes. With it, a pilot could reconnoiter enemy lines, land on an unprepared strip, remove his wings, and drive in to headquarters to report.

2. A "convertiplane." This one will rise or descend vertically, like a helicopter, and will have "considerable forward speed" like an airplane.

3. A helicopter that will carry a pay load of twenty-five tons. A big one today carries two to four tons. Only the Air Force's very largest transport planes can carry a 25-ton load. If the Army gets a helicopter of that dimension, it presumably could lift equipment as heavy as the new Walker tank.

The Air Force has also been increasing its air power. Intensified security precautions have marked the initiation of factory tests for the new Air Force XB-52 all-jet global bomber.

> *Air Secretary Thomas K. Finletter was the source of the unusual security directives, which included the stipulation that no photographs would be released until it is certain that details of the craft's exterior can no longer be kept from "potential enemies." He called upon news media to cooperate in withholding details of the plane's appearance and performance.*

Earlier, the XB-52 was described as "similar to," but larger than, the Boeing B-47 medium jet, and the new plane has been heralded as one of the two planes which may become the successor to the B-36. The other craft in this category is Convair's XB-60, an all-jet version of the B-36, with swept-back wings. The comparison with the swept-back-wing B-47 would indicate that the experimental XB-52, for which production orders already have been placed, is also in the 600-mile-an-hour class.

Secretary Finletter said that "every effort will be made to protect the security of the aircraft by means of drapes, camouflage, and other procedures." He predicted that, once tests have been satisfactorily completed, the XB-52 can be placed in production swiftly because of the experience already gained in turning out the B-47.

A production order for the manufacture of the F-89D, the Air Force's jet-propelled, all-weather interceptor, was recently placed with Northrop Aircraft, Inc., of California.

> *The F-89D's electronic aiming and automatic triggering equipment enables the pilot to direct the fire of his high-speed, high-explosive rockets with pin-point accuracy.*

This new aircraft is based on the design of other F-89 planes now in operational units of the Air Force. It is equipped with twin-jet engines which give it the rate of climb necessary for the interceptor-type plane, and with airborne radar equipment which enables it to seek out possible enemy planes at night or under adverse weather conditions. Retained in this model are the Northrop-devised "decelerons," or aërial speed brakes, which enable the plane to slow down rapidly in flight or to descend almost vertically under full control.

Cost Unconscious!

An Editorial

ALL the defense efforts of the free world, whatever immediate purpose they serve, are focused upon one dominant objective—the prevention of war without the surrender of the liberties that are dearer to free men than their lives or any material thing they possess.

These efforts are directed toward creating and maintaining so much defensive strength—moral, military, and economic—that the aggressor must be persuaded of the hopelessness of his scheme of world conquest and the certainty of his own eventual destruction if he attempts to win by force what he cannot otherwise obtain. No patriotic and loyal American can have any quarrel with these noble objectives of freedom and peace.

It can also be said with equal certitude that very few people have any doubt about the design of Soviet Russia. It may be recalled that within the last eleven years Soviet Russia has been increasing its tributary territory at the astounding rate of forty-four square miles an hour. If we should permit the strength of the other nations of the free world to continue to be added to the strength of the Communists, then surely our own freedom would ultimately be destroyed. We therefore find ourselves in what ought to be a genuine partnership with the other free nations for the security of all.

The underlying philosophy of our national-preparedness program makes considerable sense. But we do take very serious objection to the extravagant means that are currently being employed to strengthen the ramparts of free institutions everywhere.

We have been, and are continuing to be, extraordinarily wasteful and prodigal in practically every phase and aspect of the national-defense program.

We have wasted and are wasting priceless American lives. We who are very fond of talking about the dignity and sanctity of human life have suffered the unparalleled loss of more than one hundred thousand casualties in Korea.

We are inclined to boast about the vastly greater number of Communist casualties. We are justly proud of the great progress that has been made in preventive medicine and the care of the wounded. But we have not yet faced up to the fact that we are slowly bleeding to death in Korea and that this tragic sacrifice of young American lives could have been avoided.

We Have Wasted Money

We have wasted and are wasting good American money. It is the popular belief throughout Europe that every American soldier on the continent with the rank of sergeant has his own private jeep. This may be a gross exaggeration. Maybe each sergeant is sometimes asked to share his jeep with another sergeant—particularly a master sergeant. But the general lush picture is true. It seems to be axiomatic that whatever we do, or attempt to do, under whatever circumstances, even at the risk of national bankruptcy, must be done in the grand manner.

We Have Wasted Time

We have wasted time. If there is any sense of crisis or urgency on the American scene as we begin a new year, it is not visible to the naked eye. Most of us seem to be keenly interested about everything else under the sun except the national defense: Business as usual; politics as usual; graft, fraud, corruption, and mink coats as usual. We are dragging our big feet and riotously squandering our most valuable and most precious asset. We are wasting time with both hands.

An immediate conclusion is that we have not yet learned the lessons taught by World Wars I and II. On the record, we are an incredibly stupid and weathercock people. We trusted Soviet Russia. We thought that lasting peace could be achieved by merely wishing for it. We deluded ourselves into thinking that military weakness would be a deterrent to aggression. We lost contact with the rest of the battered and half-starved world and retired, with calm and impressive dignity, to the pleasant seclusion of our television rooms. We have not profited by our past mistakes.

The only faltering ray of sunshine on the present spendthrift scene is that a few people are slowly becoming aware of the fact that we cannot achieve world security at the price of American insolvency.

Both the Navy and the Marine Corps have taken steps to correct the deficiencies charged in a recent Senate Preparedness Subcommittee investigation. The two services have belatedly adopted a recommendation that the ability to economize and prevent waste be considered in rating the efficiency of officers in the future.

Not to be surpassed by the Navy in at least paying tribute to the noble ideal of economy, the Army has embarked upon what it describes as "a concerted and continuing program of cost-consciousness."

Secretary of the Army Frank Pace, Jr., recently had this to say: "The cost element alone involved in equipping our forces properly for war is a tremendous drain on the Nation's economic resources and a heavy burden upon the American taxpayer. Every effort must be made by all concerned to obtain the ultimate value from our appropriated dollar."

This is the most sensible thing the Army has said in a long time. There are indications that the Air Force is likewise driving home for all hands the absolute necessity of keeping the costs down. But it is an unceasing battle and it must be waged relentlessly. Another such year of cost unconsciousness as 1951, in which we tossed our largesse to the four corners of the earth, and the American taxpayer will have a moral duty to demand that waste be declared a criminal offense—from private to president—and that penalties be imposed as fit the crime!

ASSOCIATION AFFAIRS

• **AT NEW YORK.**—A record attendance of 1,855 members and guests of the Association attended the Industrial Mobilization Dinner Meeting under the auspices of the New York Post at the Waldorf-Astoria, December 5, 1951. Members of the Atomic Energy Commission were the guests of honor, and Gordon Dean, Chairman of the Commission, was the principal speaker. James L. Walsh, president of the Association was toastmaster; Vice Adm. George F. Hussey, Jr., president of the Post, presided. The invocation was given by the Rev. Dr. Julius Mark, senior rabbi, Congregation Emanu-El of the City of New York.

Preceding Mr. Dean's address (which will be published in the next issue of this journal), the Adm. W. H. P. Blandy Gold Medal of the Association was presented to Adm. Albert G. Noble, retired former Chief of the Bureau of Ordnance, Department of the Navy. The presentation was made on behalf of the Association by Admiral Blandy, who read the citation accompanying the award and spoke in tribute to the outstanding record of Admiral Noble throughout his long Navy career. The committee of the New York Post in charge of the meeting comprised John G. Phillips, chairman, and the following members: J. L. Auer, P. R. Bassett, T. F. Brown, C. Stewart Comeaux, Charles Cox, Paul T. Cullen, Will Eisner, B. F. Fairless, Crosby Field, Max Greenberg, J. M. Gruitch, H. T. Luria, D. B. MacMaster, R. L. Maxwell, Chester Mueller, T. I. Parkinson, H. Robert Samstag, P. B. Scott, L. W. Stearns, L. C. Stowell, Frederick Tomkins, A. E. Van Cleve, and J. S. Walker.

In conformity with traditional practice the excess of receipts over expenditures from the meeting will be donated to charitable and relief purposes of the armed services.

• **DIRECTORS' MEETING.**—Incident to the Industrial Mobilization Dinner at New York on December 5th, a meeting of the Board of Directors of the Association was held at 10:30 a.m. that day in the Council Room of the University Club. Activities of the Association during the current year were reviewed by members of the staff of national A.O.A. headquarters, and policies governing the programs and activities of the Association for the coming year were considered at length.

James L. Walsh, president of the Association, presided at the meeting, and the following directors and officers were present: Vice-Presidents Herbert A. Gidney, Harvey C. Knowles, Louis Polk, Robert L. Biggers, and John S. Pfeil; Directors William W. Coleman, Frederick H. Payne, John Slezak, R. E. Gillmor, W. H. P. Blandy, Levin Campbell, C. Jared Ingersoll, K. T. Keller, Charles D. Wiman, Donald F. Carpenter, C. Stewart Comeaux, and J. E. Trainer.

Also in attendance were John Ross Delafield, counsel; Henry N. Marsh, general chairman, Divisions and Committees; Leo A. Codd, executive vice-president; Florence G. Ferriter, secretary; Roger E. Lewis, managing editor of A.O.A. publications; and Burton O. Lewis, staff consultant.

Principal matters of policy discussed were programs and activities of local Posts of the Association and principles governing the activities of Technical Divisions and Committees.

In the former field it was recommended that individual national officers of the Association meet with the boards of directors of Posts at least once a year to offer every assistance to the programming of meetings, providing speakers, assisting with plant visits and demonstrations, and developing liaison with the various establishments of the armed forces within the respective areas of the Posts. Considerable emphasis was placed on the advisability of establishing a speaker's bureau to assist in furnishing qualified speakers for Post functions.

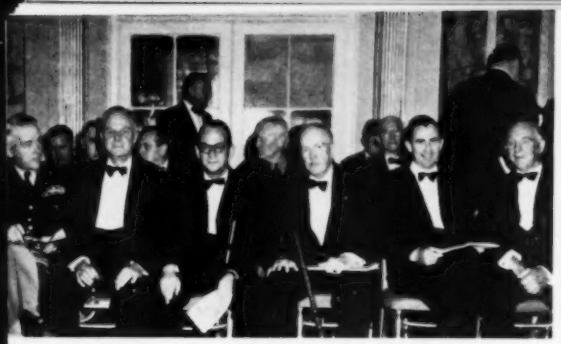
A statement of policies governing the principal activities and procedures of the Technical Divisions and Committees was agreed upon. It will be published in full in the next issue of this magazine after transmittal to the chairmen of all Divisions and Committees.

Henry N. Marsh was confirmed as general chairman of Divisions and Committees, succeeding Louis Polk who had assumed the vice-presidency in charge of Divisions and Committees. Mr. Polk is president of the Cincinnati Post of the Association and president of the Sheffield Corporation, Dayton, Ohio. Colonel Marsh has long been identified with the explosives industry of the United States and is an official of the Hercules Powder Company, Wilmington, Del.

A special committee of officers will be appointed to consider and recommend the time and place for the Thirty-Fourth Annual Meeting of the Association to be held in the spring of 1952.

• **AT LANSING.**—Maj. Gen. Fred. R. Dent, Jr., Commanding General, Wright Air Development Center, United States Air Force, was the principal speaker and guest of honor at a meeting of the Lansing Chapter, American Ordnance Association, held in the Oldsmobile Auditorium, Lansing, on Tuesday, November 27th, at which more than 700 Post

Adm. W. H. P. Blandy, left, pins the Blandy Medal on Adm. Albert G. Noble, right.



As honor guests assembled for the A.O.A. Industrial Mobilization Dinner at the Waldorf-Astoria, New York, December 5, 1951.

Left to right: Gen. J. Lawton Collins, Chief of Staff, U. S. Army; S. C. Hope, president, Hartford-Springfield Post, A.O.A.; Maj. Gen. E. L. Ford, Chief of Ordnance, U. S. Army; Harvey C. Knowles, vice-president, A.O.A.; Louis Polk, vice-president, A.O.A.; Maj. Gen. R. L. Maxwell, New York Committee, A.O.A.; Gordon Dean, Chairman, Atomic Energy Commission; Lieut. Gen. Willis D. Crittenberger, Commanding General, First Army; James L. Walsh, president, A.O.A.; Dr. Allen V. Astin, Acting Director, National Bureau of Standards; Frederick H. Payne, Director, A.O.A.; Frank Pace, Jr., Secretary of the Army; and Herbert A. Gidney, vice-president, A.O.A.

Principal participants in the A.O.A. Industrial Mobilization Dinner Meeting at the Waldorf-Astoria, New York, December 5, 1951.

Left to right: John G. Phillips, president, International Business Machines Corporation, chairman, Reception Committee; Adm. Albert G. Noble, former Chief, Bureau of Ordnance, U.S.N., recipient of the A.O.A. Blandy Gold Medal for Distinguished Ordnance Service; Vice Adm. George F. Hussey, Jr., former Chief, Bureau of Ordnance, U.S.N., president, New York Post, A.O.A., who presided at the dinner meeting; Gordon Dean, Chairman, United States Atomic Energy Commission, who delivered the principal address; James L. Walsh, president, American Ordnance Association, who was toastmaster; and Adm. W. H. P. Blandy, also a former Chief of Navy Ordnance.

members and guests were in attendance.

Sharing the rostrum with General Dent was S. E. Skinner, vice-president of General Motors Corporation and a founder of the Lansing Chapter. Lester V. Carlson, president of the Chapter, presided.

General Dent's address described present problems and current developments in the vast field of aircraft-armament progress. He showed for the first time a film describing the tests and demonstrations at Wright Field on October 5th when more than 3,000 members of the Ordnance Association were guests of the Air Force at the Thirty-Third Annual Meeting of the A.O.A.

The film is tremendously interesting and will be available shortly through National Headquarters of the Association for loan to local Posts, educational institutions, and patriotic societies as a sterling example of industry-armed forces coöperation. Announcement concerning the availability of the film will be made to all Posts shortly.

Mr. Skinner spoke at length of the plan for dual-purpose plants as proposed by C. E. Wilson in an address before the members of the A.O.A. at their annual meeting in Cincinnati, October 1951. In elaborating on the Wilson plan Mr. Skinner stressed the point that dual-purpose plants are not necessarily new plants or plants constructed solely for a dual-purpose output. On the contrary, the Wilson principle applies to all plants presently in production.

Mr. Skinner emphasized that all current arms-producing establishments, large and small, which hold production facilities in stand-by while utilizing other facilities for current peacetime products are, strictly speaking, dual-purpose plants. This is so, he said, because they can share the same overhead facilities such as personnel, cafeteria, shipping, storage, and other facilities.

Preceding the meeting a dinner was served to all members and guests. Special acclaim was accorded Thomas C. Downey of the Lansing Chapter who has broken all records in enrolling individual members of the Chapter. During the month preceding the meeting, Mr. Downey personally directed the enrollment of more than 200 A.O.A. members.

• **AT DETROIT.**—The annual dinner of the Michigan Post was held on Wednesday, December 12th, in the Grand Ballroom of the Book-Cadillac Hotel. Lieut. Gen. Edward H. Brooks, Commanding General of the Second Army, and Col. S. L. A. Marshall, military critic of the *Detroit News*, were the guest speakers. Since this issue of ORDNANCE goes to press as the meeting is held, a more complete account will be published in the succeeding issue.

Plans for the meeting were under the supervision of the following officers of the Post: Kenneth B. Coates, president; Robert L. Biggers, first vice-president; S. E. Skinner, second vice-president; Lester R. Downie, secretary-treasurer; and the following directors: Mr. Biggers, Henry T. Bodman, Harold R. Boyer, Walter O. Briggs, Jr., Mr. Coates, John S. Coleman, Joseph M. Dodge, Benson M. Ford, Edward T. Gushée, George W. Mason, Charles S. Mott, John W. Paynter, George H. Roderick, Mr. Skinner, and Herbert J. Woodall.

• **AT SHREVEPORT.**—Robert L. Telford, a resident of Shreveport, a director of the Louisiana Post, and for many years a leading figure in the Ordnance fraternity, has been chosen chairman of the Association's Rocket, Bomb and Artillery Ammunition Division. He succeeds in this capacity Harvey C. Knowles who organized the Division following World War II and who has served as its chairman since that time. Mr. Knowles will continue as a vice-president of the Association and a member of its board of directors and executive committee.

Bob Telford is first vice-president of the Silas Mason Company and vice-president of Mason & Hanger Company. Both are well-known firms of engineers and contractors whose speciality is heavy construction. Mr. Telford has been continuously engaged in engineering and production work for Army Ordnance since 1940. A major portion of his time and talent has also been engaged in performing architect-engineer and other services for the Atomic Energy Commission.

Prior to taking up his duties as vice-president of the Mason companies in 1943 he served as engineer, superintendent, and manager on various important projects, including the construction of powder plants and shell and bomb loading plants.

Mr. Telford has also directed major engineering operations, such as subway and vehicular tunnels in New York and Boston, Grand Coulee Dam, and Hudson River Bridge foundations.

Mr. Telford brings to his new Association assignment a world of experience, unusual industry, and outstanding administrative ability.

• **AT BOSTON.**—A new slate of officers has taken up the reins of the Yankee Post. Active plans were made for a year's program aimed at making the Post of maximum value to the members.

The first full meeting of the Post for the current season was held at Watertown Arsenal on December 11th. The session began with a 2-hour conducted tour of exhibits throughout the arsenal.

The tour included a showing of the centrifugal casting pouring operation, a laboratory exhibit of metallurgical proc-

While the Reception for honor guests was in progress at the A.O.A. Industrial Mobilization Dinner Meeting at the Waldorf-Astoria.

Left to right: Maj. Gen. E. L. Ford, Chief of Ordnance, United States Army; Herbert A. Gidney, vice-president, American Ordnance Association; an unidentified guest; James L. Walsh, president, American Ordnance Association; Gen. J. Lawton Collins, Chief of Staff, United States Army; Vice Adm. George F. Hussey, Jr., president, New York Post, A.O.A.; Adm. Albert G. Noble, American Ordnance Medalist; Thomas E. Murray, member, Atomic Energy Commission; Mrs. C. Jared Ingersoll, Philadelphia, Pa. Those in the receiving line stood in the Silver Corridor in the Waldorf and greeted the guests as they entered the foyer of the Grand Ballroom. Among other guests of honor not appearing in these photographs were: John F. Floberg, Assistant Secretary of the Navy; Karl R. Bendetsen, Assistant Secretary of the Army; R. L. Gilpatrick, Under Secretary of the Air Force; K. T. Keller, Director of Guided Missiles, Department of Defense; and Louis Johnson, Secretary of Defense, 1949-1950.

Just before entrance of honor guests at the A.O.A. Industrial Mobilization Dinner Meeting in New York, December 5, 1951.

Left to right: Archibald Alexander, Under Secretary of the Army; Marion W. Boyer, General Manager, Atomic Energy Commission; Donald F. Carpenter, director, A.O.A.; Thomas E. Murray, member, Atomic Energy Commission; Rear Adm. J. A. Snackenberg, Deputy Chief, Bureau of Ordnance, U. S. Navy; John S. Pfeil, vice-president, A.O.A.; C. Jared Ingersoll, director, A.O.A.; Vice Adm. Donald B. Duncan, Vice Chief of Naval Operations, U. S. Navy; Lieut. Gen. Henry S. Aurand, Commanding General, United States Army, Pacific; Vice Adm. George F. Hussey, Jr., president, New York Post, A.O.A.; Charles D. Wiman, director, A.O.A.; Lieut. Gen. Leslie R. Groves, Chief, Manhattan Project, World War II; Lieut. Gen. Levin H. Campbell, director, A.O.A.; Rear Adm. B. Hall Hanlon, Commandant, Naval Gun Factory, Washington, D. C.; R. E. Gillmor, director, A.O.A.; H. R. Boyer, Chairman, Aircraft Production Board; and Admiral Albert G. Noble, A.O.A. Medalist.

ess, applied mechanics, studies of an artillery weapon's life and erosion, studies in the physics of various metals, including titanium, a demonstration of the automatic magniflux-inspection method, the testing of metals at high and low temperatures, the showing of a new electronic method of cutting hard alloys to very fine tolerances, and the showing of a combined X-ray and television method of analyzing castings and other metallic components for flaws without destroying the piece.

Following the tour and an excellent roast beef dinner (to rival the best anywhere!) in the Officers' Club, Col. Benjamin S. Mesick, commanding officer of Watertown Arsenal and one of the Nation's authorities on titanium metal and its alloys, gave a very instructive talk on the importance of titanium, not only for military applications but as a new material for metal fabrication generally where its special properties offer advantages.

At an earlier meeting in October, Yankee Post directors proposed that the constitution and by-laws of the Post be amended to recognize changes in terminology consistent with the unification of the armed services and with the new nomenclature of subdivisions of the Department of Defense. The full membership at the Watertown meeting approved the changes.

The officers of the Yankee Post are: president, Lynn H. Morse; vice-presidents, H. A. Wansker, John J. Meyer, and W. Bruce Loomis; and secretary-treasurer, Helge Holst. The directors are: J. P. Spang, Jr., chairman; E. W. Miller, R. N. Greenwood, C. F. Carlstrom, Elliott M. Gordon, L. J. Meyns, R. S. Morse, R. F. Williams, J. S. Crawford, D. A. Lenk, J. Carlton Bagnall, G. P. Blade, and J. J. Brogan.

Present at the Lansing Chapter meeting were, left to right: L. F. Carlson, chairman of the Lansing Chapter; Maj. Gen. Fred. R. Dent, Jr., Commanding General of the Wright Air Development Center, Dayton, Ohio; S. E. Skinner, General Motors vice-president; J. F. Wolfram, General Motors vice-president and general manager of the Oldsmobile Division; and Joseph A. Anderson, works manager, AC Spark Plug.

• **AT EGLIN AIR FORCE BASE.**—Lieut. Col. R. F. Garner, Jr., U.S.A.F., president of the Florida Post, recently visited the Air Force Missile Test Center, Cocoa, Fla., and had a pleasant chat with Col. Charles G. Mettler who spends the winter season in Miami and has the opportunity to meet with other Association members who likewise spend their winters in Miami.

As a result of this conversation, tentative plans were made to hold a meeting of the Post in Miami during the winter season.

Quite recently the Post inaugurated a newsletter to be distributed to all Post members. Good progress is being made in selecting various members to serve on the committees which have now been activated. In this connection, the counsel of Earl C. Williamson of Jacksonville has been most helpful.

• **AT ALBANY.**—The first dinner meeting of the Capital Cities Post during the current season was held at Panetta's Restaurant, Menands, N. Y. Harry L. Erlicher, Post president who is now special assistant to the Under Secretary of the Army, was toastmaster. The principal speakers were Lieut. Gen. Frank W. Milburn, recently returned from Korea, and Harry E. Blythe, small-business consultant to the Chairman of the Munitions Board.

Dr. Livingston W. Houston, president of Rensselaer Polytechnic Institute and chairman of the Post Committee on Student Activities, presented a report on engineer student enrollment.

In his introductory remarks, Mr.

Erlicher emphasized the magnitude of private industry's production task today by citing the fact that a ton of supplies a month must be furnished for every American soldier in Korea.

General Milburn declared that the American Eighth Army will never be pushed out of Korea. While respecting such an enemy as the Chinese, he asserted that they are no match for a mechanized, well-equipped, modern army.

"We are outnumbered ten to one," he said, "but with the equipment that you men provide, we will more than hold our own."

Mr. Blythe spoke of the importance of small business in Government plans for increased production. He stressed the fact that Government is interested in seeing that "small business gets its share," and he showed, through figures, that this is already so.

Dr. Houston reported that the reduction in engineering student enrollment in the Nation's colleges since 1947 has been so sharp that there are not now enough engineering students to meet even the needs of a peacetime economy, not to mention the expanding military mobilization and the expanding industrial defense program.

Dr. Houston suggested ways by which the acute situation could be helped. The first and most important thing, of course, was to increase engineering freshman enrollment in the colleges. To accomplish this he urged the fullest possible publicity which would point out the need, and greater coöperation in secondary schools to discover and qualify more students for engineering studies in the colleges.

Prior to the dinner meeting, visiting military and Government representatives toured the facilities of Watervliet Arsenal with Col. Harry Rising, arsenal commandant.

Other officers for the current season are Ledyard Cogswell, Jr., first vice-president; Sanford L. Cluett, second vice-president; Hiland G. Batcheller, immediate past president; and Edward S. Webster of Watervliet Arsenal, secretary-treasurer.

The new directors also include John T. Cummings, Paul S. Hamilton, Charles Kirschenbaum, Chester H. Lang, Albert H. Maggs, Brig. Gen. Wendell Westover, Col. Harry N. Rising, Ernest E. Johnson, and Leon W. Dwyer.

Chairmen of standing committees are John O. Amstuz, Industrial Preparedness; and Dr. W. E. Ruder, Technical Progress.

• **AT ANN ARBOR.**—The first regular meeting of the current season was held on November 1st when Prof. E. T. Vincent, chairman of the Department of Mechanical Engineering at the University of Michigan, addressed the group on the subject of jet propulsion.

Future plans of the University of Michigan Post include a trip to the Willys-Overland plant in Toledo.

Present officers of the Post are Gerald F. Fox, president; Jack O. Gillett, vice-president; and L. Ronald Modlin, secretary-treasurer.

Following presentation of an A.O.A. check for $7,123.70 to the Air Force Aid Society, Louis Polk (right), vice-president in charge of Technical Divisions and Committees of the A.O.A., and president of the Sheffield Corporation, Dayton, Ohio; and Harvey C. Knowles (left), vice-president of the Association and vice-president of Procter & Gamble Company, Cincinnati, chat with Lieut. Gen. E. W. Rawlings, Commanding General, Air Matériel Command, Wright-Patterson Air Force Base, Dayton.

• **AT BIRMINGHAM.**—At the annual meeting of the Birmingham Post, December 7, 1951, Maj. Gen. E. L. Ford, Chief of Army Ordnance, was the honor guest and principal speaker. He addressed nearly 200 members of the Post at a dinner meeting held that evening at the Tutwiler Hotel. The theme of his remarks was that it is everybody's job to put superior ordnance in adequate quantities into the hands of our troops.

Merrill E. Pratt, president, Continental Gin Company, and president of the Post, presided. Col. William J. Rushton, chief of the Birmingham Ordnance District, presented General Ford to the audience.

The dinner meeting was the climax of a day-long program of activities by the Post. At 9:30 a.m. members were taken by chartered bus for an inspection tour of the Anniston Ordnance Depot and plant now forging and machining 105-mm. shell. Luncheon was served at the depot. The party returned to the Tutwiler Hotel at 4:45 p.m.

At an election of officers, Mr. Pratt was succeeded as president by Claude S. Lawson, president, Sloss Sheffield Steel & Iron Company. Mr. Pratt was chosen to represent the Birmingham Post on the Council of the American Ordnance Association. Other officers who were elected are: Vice-president, *Bradford C. Colcord*, president, Woodward Iron Company, Woodward, Ala.; treasurer, *Robert D. Cotten*, Protective Life Insurance Company, Birmingham, Ala.; secretary, *Ralph E. Parker*, 8328 First Avenue, South, Birmingham, Ala. The following directors were also elected: *Allen J. Armstrong*, Cedar Grove Plantation, Natchez, Miss.; *James M. Barry*, president, Alabama Power Company, Birmingham, Ala.; *J. L. Bedsole*, owner, Williams Box Company, Prichard, Ala.; *Hugh P. Bigler*, executive vice-president, Chamber of Commerce, Birmingham, Ala.; *D. W. Blend*, plant manager, Wolverine Tube Division, Decatur, Ala.; *Robert C. Crumbaugh*, manager, E. I. du Pont de Nemours & Company, Birmingham, Ala.; *K. R. Daniel*, chief engineer, American Cast Iron Pipe Company, Birmingham, Ala.; *R. S. Lynch*, president, Atlantic Steel Company, Atlanta, Ga.; *C. Pratt Rather*, president, Southern Natural Gas Company, Birmingham, Ala.; *Walker Reynolds*, president, Alabama Pipe Company, Anniston, Ala.; *A. V. Wiebel*, president, Tennessee Coal, Iron & Railroad Company, Birmingham, Ala.; *B. C. Blake*, vice-president and general manager, Connors Steel Company, Birmingham, Ala.

• **AT DAYTON.**—The American Ordnance Association donated $7,123.70 to the Air Force Aid Society. This sum represented the excess of receipts over expenditures of the Thirty-Third Annual Meeting of the Association at Cincinnati and at Wright-Patterson Air Force Base in Dayton, October 4 and 5, 1951.

The presentation was made at the Base by Louis Polk, president of the Sheffield

Corporation, Dayton, a vice-president and director of the Association and president of the Cincinnati Post. The check was received by Lieut. Gen. E. W. Rawlings, Commanding General, Air Matériel Command.

It is a traditional Association policy to donate the surplus from its annual meetings to the relief or aid society of the host service. The 1951 contribution was more than twice as large as any made in the past.

The Air Force Aid Society furnishes emergency financial assistance to Air Force personnel in time of illness or death. It also supports an educational fund for college-age children of airmen.

Also present at the ceremony were: Maj. Gen. Fred. R. Dent, Jr., commander of the Wright Air Development Center; Harvey Knowles, vice-president, Procter & Gamble Company, a senior vice-president of the Association; and Clarence Hamilton, assistant to the president of the Sheffield Corporation.

Subsequently the following letter was received by the Association from Gen. Hoyt S. Vandenberg, Chief of Staff, United States Air Force:

"On behalf of the United States Air Force, I wish to express again our appreciation of the generous gift the American Ordnance Association has made to the Air Force Aid Society. The good will of your Association has contributed immensely to the support of the Air Force Aid Society in achieving its goal of providing emergency financial assistance to all Air Force personnel and their dependents."

• **AT SYRACUSE.**—One hundred and fifty members of the Syracuse-Central New York Chapter of the Empire Post gathered for the annual meeting of the Chapter at the Hotel Onondaga, Syracuse, on December 10, 1951. The Chapter was formally welcomed by the Central New York Inspector of Naval Material, Comdr. A. W. Czehatowski. A special guest at the meeting was Col. Harry H. Haas, deputy chief of the Rochester Ordnance District.

The principal speaker of the evening was Brig. Gen. Emerson L. Cummings, chief of the Industrial Division of Army Ordnance, who described in detail the current objectives of the ordnance production program.

Announcement was made of the resignation from the Empire Post and from the Chapter of Carl Dietz, a founder of the Chapter and long-known throughout the United States for his leadership in ordnance-industry activities. Mr. Dietz is moving to New York City and while retaining the presidency of the Lamson Corporation of Delaware has relinquished direct administrative responsibilities for the subsidiary, Lamson of Syracuse.

John D. Williams, vice-president of Lipe-Rollway Corporation, was succeeded as chairman of the Chapter by Ray C. Malvin, vice-president and general plant manager of Fitzgibbons Boiler Company of Oswego. Other officers of the Chapter are:

First vice-chairman and meeting chairman, *Stanley H. Ellison,* executive assistant, Carrier Corporation, Syracuse;

Second vice-chairman and membership chairman, *John I. Dean,* assistant sales manager, Porter-Cable Machine Company, Syracuse;

The following vice-chairmen were also elected: *George R. Auld,* vice-president, Manufacturing, Carrier Corporation, Syracuse; *Fred N. Claypole,* factory manager, Brown-Lipe-Chapin Division, GMC; *Robert I. Hicks,* president, Lamson Corporation, Syracuse; *Richard W. Noyes,* research engineer, Oneida, Ltd., Oneida; *Charles D. Osborne,* publisher, *Auburn Citizen-Advertiser,* Auburn; *Mark Russell,* chief engineer, Pass & Seymour, Inc., Syracuse; and *Louis K. Sillcox,* president, New York Air Brake Company, Watertown.

Gwyn Thomas, public relations director, Manufacturers Association of Syracuse, was elected secretary of the Chapter.

• **RICHARD D. STEUART,** veteran newspaperman and charter member of the American Ordnance Association, died at his home in Baltimore, Md., October 15, 1951. He was a world-renowned expert on firearms of the Confederacy.

An acknowledged authority on the history of Maryland and of the Southern States, Mr. Steuart wrote for many years under the pen name of Carroll Dulaney.

A collector of firearms specializing on Confederate Colts, Mr. Steuart's priceless collection is displayed at Fort McHenry, Baltimore. In 1934 he published in this magazine "The Story of the Confederate Colt" a scholarly and definitive presentation which has become a standard work of reference. The issue of ORDNANCE magazine containing Mr. Steuart's discussion of the Confederate Colt (September-October 1934) is long since out of print, and copies of it are avidly sought by collectors and other students of the subject.

Mr. Steuart was one of the few writers on behalf of the American press whose pen never wavered in defending American ordnance during the wave of pacifism in the United States during the 1930's. He was a staunch supporter of adequate preparedness and of the American Ordnance Association and other patriotic organizations. For his wisdom and candor, for his loyalty to the best traditions of the South as well as his deep knowledge of Confederate arms, "Dick" Steuart will long be remembered and admired by the Ordnance fraternity.

• **RAYMOND CHARLES FORCE,** former president of the San Francisco Post of the American Ordnance Association, died on November 15, 1951, in Oakland, Calif. He was an outstanding pioneer in the Ordnance movement and, together with Pliny Holt, was one of the first organizers of the Association on the West Coast.

Mr. Force was first president of the Caterpillar Tractor Company and a member of its board of directors. Known for his business integrity and sound judgment, Mr. Force laid the foundations for many basic policies which have guided Caterpillar's growth since it was founded in 1925. He served as the company's president until 1930 and then became chairman of its executive committee and a member of the board.

He manifested constantly his keen interest in all matters pertaining to the national defense, and it was always possible to count upon his utmost cooperation in advancing the interests of the Association. His passing is deeply mourned by his many friends and associates in civilian and military life.

• **C. L. BEST,** pioneer inventor and tractor builder, died September 22, 1951, at San Francisco, Calif. One of the founders of Caterpillar Tractor Company, he was chairman of the board and member of the executive committee at the time of his death.

He opened his own farm machinery factory in 1910 and continued as president of his firm until 1925 when it and the Holt Manufacturing Company were merged to form the Caterpillar Tractor Company. Mr. Best became chairman of the board of the new organization.

Throughout his long business career he always took a keen interest in national-defense problems and will always be remembered for his many fine contributions to ordnance.

• **CLYDE WHITLATCH,** long a member of the Ordnance fraternity, died at Bradenton, Fla., on September 7, 1951. Following a distinguished military career, Mr. Whitlatch continued to serve Ordnance in a civilian capacity. His first assignment, following his military retirement, was in Field Service, Office of the Chief of Ordnance. In 1943 he served with Ordnance overseas and, upon his return to the United States, joined the Field Service Office at Rock Island Arsenal.

Colonel Whitlatch was noted as an expert rifleman and was a member of the Ordnance Reserve Officers' Rifle Team in New York City that won the McNary Cup.

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New DEVELOPMENTS

ENGINE-PARTS STANDARDIZATION

A 4-year program to standardize the high-mortality parts of gasoline engines used by the Army, Navy, and Air Force is nearing completion. Maximum interchangeability is also being achieved. On 138 different engine models, 1,187 different fast-moving parts could be reduced to a family of only 63 parts, and 15 bore sizes could be reduced to 5 basic sizes. The program will be expanded to cover Diesel engines.

ONE-MAN HELICOPTER

The world's first rocket helicopter has been developed by Rotor-Craft Corporation of Glendale, Calif. It weighs less than 100 pounds, can be parked in a space no larger than the top of an office desk, and is designed to carry one man and special armament at a rate of climb never before held possible for helicopters. Liquid-fuel rockets, self-starting and throttle-controlled, are mounted in the tips of two small rotor blades. The rotor is attached to a steel tube which curves downward to support fuel tanks, a pilot's seat, and cargo hook. A tube extending backward from the rotor hub carries a small rudder, and another extending forward and down is the pilot's control column. That's all there is to it.

The weird little machine is known as the "Pinwheel," and has been developed for the Office of Naval Research. Ground tests were begun recently at a military base in the Los Angeles area. With power off it can glide like an airplane or descend vertically like a parachute. Its rocket motors display no flame, and in approaching an enemy location at night it would be next to impossible to spot the darting little machine and its pilot. Photos of the new machine are restricted but the accompanying artist's sketch shows the approximate configuration of the one-man device.

NEW ARMORED VEHICLES

A number of armored vehicles, forming a family of medium and heavy tanks and related weapons built around the 810-horsepower AV-1790-5b Ordnance-Continental air-cooled motor, were described recently by the Army.

On the list are: A new medium-gun tank, designated the T48; a new gun motor carriage, the T97; a new howitzer motor carriage, the T108; a new heavy-gun tank, the T43; and a new engineer armored vehicle, the T39.

The T43 will carry a 120-mm. gun, the heaviest weapon yet carried by an American tank. The T97 gun motor carriage is designed eventually to replace the M40 now in use in Korea. It mounts a 155-mm. gun and at least one caliber .50 machine gun. Further details are classified.

The M47 is an improved model of the M46 Patton, now fighting in Korea. The T39 armored bulldozer carries a gun, a boom and other equipment.

Other new Army vehicles are the T44 cargo tractor, which can serve as an armored tracked personnel carrier, a cargo carrier, or a heavy prime mover for such weapons as the 240-mm. howitzer; also the T51 heavy recovery vehicle designed

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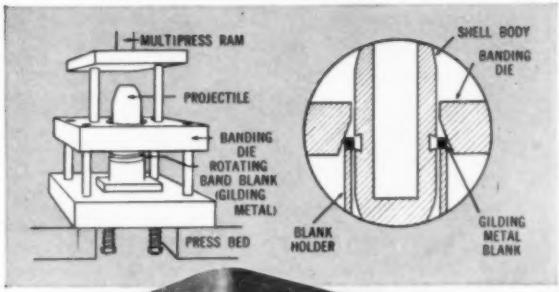

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This new Multipress shell-banding process is applicable to projectiles of almost any size. Quick, easy tool changes adapt the press shown here to 20mm, 75mm, 76mm, 90mm, 105mm, 120mm and other shell sizes.

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MILITARY PRODUCTS BY EVEREDY

The composite photo above shows some of the products made by Everedy during World War II. This material covered a wide range of sizes and shapes; from 8" diameter spherical steel Floats for the Navy to small Folding Fin Assemblies for Air Force Rockets. Quantities ranged into the millions. Operations on the various products included shearing, stamping, drawing, forming, grinding, drilling, plating, welding, polishing, lacquering, spray-painting and many others. In the case of several products, Everedy's ingenuity in devising new production methods, and the equipment to go with them, brought about very substantial savings in time, money and manpower . . . the three essentials in any production.

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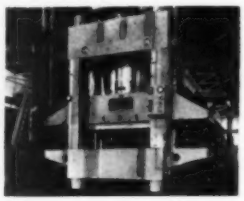
to recover disabled tanks from the battlefield even during a battle.

ARMOR PLATE QUENCHING PRESS

The giant 2500-ton armor plate quenching press shown here is one of several now being built by the Hydraulic Press Manufacturing Company, Mount Gilead, Ohio. Designed for armor-plate production, this press will handle large plates from one-half to two inches in thickness. It has an over-all bed size measuring 72 by 235 inches. Clearance between rod shields is 98 by 72 inches. Hot armor plate from the hardening furnace is placed in the press and held under pressure between dies while being sprayed with cold water. Prior to the development of this hydraulic press quenching method, the plate had to be straightened after it was cooled, employing mechanical presses and permitting only a small portion of the plate to be straightened in the press at one time. This slow and tedious process taking hours is now handled by the armor plate quenching press in less than two minutes and entirely eliminates subsequent straightening operations.



REVOLUTIONARY "COLD SUIT"

The Army Quartermaster Corps is developing a revolutionary single-layer, molded-plastic, winter combat garment, employing the so-called "vapor-barrier" principle and minimizing the need for drying wet clothing in the field. The new garment is designed to be worn without underclothing under certain field conditions and would drastically reduce the number of items and the weight of winter combat uniforms.

Experiments have placed particular emphasis upon the "flotation characteristics" of the garment. Quartermaster scientists and field observers, who donned the new outfits and plunged into water over their heads, established that the buoyant garment makes a man unsinkable, even when wearing a 26-pound pack.

The immersion tests also established that such moisture as remains on the skin and on the inside of the garment, even after a thorough drenching, is promptly warmed up by normal body heat after the wearer climbs out of the water into air temperature as low as freezing. Previous tests indicated that the garment may be worn with comfort, at least in test chambers, in temperatures as low as forty degrees below zero.

LONG-BURNING FLARE

A new ingenious defensive weapon—a long-burning flare which illuminates an area several hundred feet in radius—has been invented on the Korean front by 1st Lieut. Charles J. Husch. The flare throws a bright yellow flame and lights up surrounding terrain for more than five hours.

The device is constructed from two empty shell cases filled with a mixture of Diesel fuel and gasoline and placed in a mortar ammunition container with an ordinary trip flare. The ammunition container in turn is filled with napalm, or jellied gasoline. When the flare is ignited it sets fire to the napalm in the base of the container, heating the incendiary fluid in the shell cases to the boiling point. The ensuing pressure forces burning vapor six to ten feet into the air through perforations in the tops of the cases, and the brilliant yellow flame results.

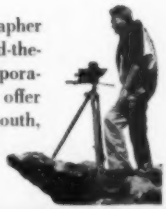
LIGHTWEIGHT BOOSTER ROCKET

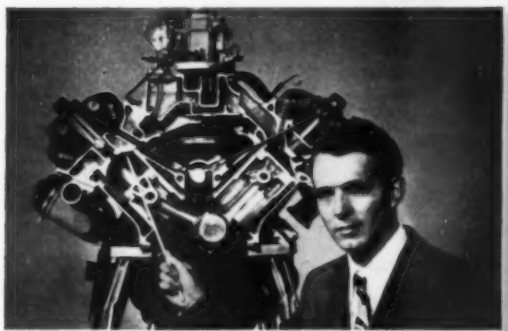
Details of a new lightweight rocket booster that can double the power of jet fighter aircraft operating at high altitudes were announced recently in London. Known as the "Snarler," the new unit is reported to have developed an extra 2,000 pounds

HOW CHRYSLER CORPORATION DEVELOPED MORE EFFICIENT CAR ENGINES

The engineering story behind high-compression power plants that squeeze more power and performance from fuel

Charles Kerlee, official Navy photographer in World War II, brings this behind-the-scenes picture story from Chrysler Corporation — the story of great engines that offer brilliant performance in the new Plymouth, Dodge, De Soto and Chrysler cars.





NEW TYPE OF ENGINE, the 180-hp. FirePower. Engineer Philip M. Rothwell points to dome-shaped combustion chamber developed by Chrysler to squeeze more power from each drop of gasoline. The FirePower, like *every* Chrysler Corporation engine, runs brilliantly on regular fuel. Chrysler high-compression engine research and development began in 1924, is reflected in today's powerful Plymouth, Dodge, De Soto and Chrysler cars.

NEWEST "GETAWAY" TEST helps measure engine response. When this Plymouth Cranbrook starts forward, the long tape runs through an electronic machine which measures how far the car moves in each 1/30th of a second. Constant testing leads to superior performance in all Chrysler-made engines, from the new and sensational Chrysler 180-hp. FirePower to the 97-hp. Plymouth engine with its high 7.0 to 1 compression ratio.

CAR WITH 9 GAS TANKS. This unique test helps engineers make engines use fuel more efficiently. Each of this De Soto's 9 special tanks feeds gasoline to the engine at certain speeds, while electronic machines record exact amount of gas used. With this information, Chrysler Corporation engineers can improve carburetors to give best performance at speeds most people drive.

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Never before has a line of micrometers offered such an outstanding combination of advanced features as the new Brown & Sharpe Micrometers.

Greater durability and accuracy are provided by the stainless steel, one-piece spindle and screw with hardened and ground threads. Easier, more accurate reading is made possible by the widely-spaced divisions, large-size thimble, black graduations, and dull chrome finish. Long-wearing carbide measuring faces assure enduring accuracy.

See these new micrometers at your tool suppliers. For illustrated folder describing the completely new line of Brown & Sharpe Micrometers, write Brown & Sharpe Mfg. Co., Providence 1, R. I., U. S. A.

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- Exclusive adjustments . . . easy, quick, accurate
- Dull chrome finish

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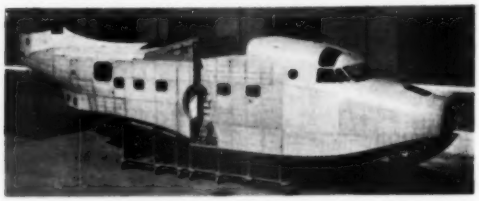
New Developments

of thrust at sea level. It measures 6 by 3 feet, weighs 215 pounds, and has been tested extensively on the new Hawker experimental aircraft P-1072. The "Snarler" is a liquid-propellant motor burning a mixture of liquid oxygen plus water and methanol. In contrast with the present rocket boosters on aircraft, which burn solids and are reduced to exhaustion once ignited, the "Snarler" can be switched on or off, and, unlike gas turbine jet engines, it does not rely on atmospheric oxygen which rapidly decreases in density with the rise in altitude. It is expected that the new motor will be of great assistance in the development of future supersonic aircraft.

PLYMOUTH FABRICATES AMPHIBIAN

Assembly of the first hull for the giant Grumman Albatross amphibious air-sea rescue plane was completed by the Plymouth Division of Chryler Corporation only five months after the corporation started work on the defense assignment. In addi-



tion, the Plymouth plant has already completed and shipped several Albatross hull subassemblies for final assembly by Grumman at Bethpage, Long Island.

The Albatross hull, shown in the accompanying illustration, measures 60 feet long, 8 feet wide, and 12 feet high. It weighs approximately 4,500 pounds, with a gross weight of 6,000 pounds when packed for shipping to final assembly. The hull consists of 9 major and several smaller subassemblies, made up of about 6,000 individual parts, all of which are to be fabricated at the Evansville plant. The Grumman Albatross is a twin-engined amphibious air-sea rescue plane used by the Army, Navy, and Coast Guard. It has already seen active duty in Korea.

TIN SUBSTITUTE

RFC Director W. Stuart Symington recently announced a newly developed substitute for tin which has "tremendous import" for the United States. The new product is a blend of plastics with aluminum foil developed by the Reynolds Metals Company of Richmond, Va. Production is starting immediately and all the output for some time will be taken by the armed services.

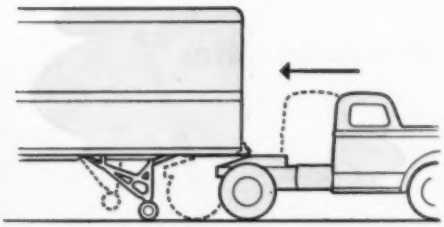
LOW TEMPERATURE LUBRICANT

A synthetic grease has been developed which operates satisfactorily on antifriction bearing surfaces and light to moderately loaded gears and screw mechanisms in temperatures as low as 100 degrees below zero Fahrenheit. Research on the project was initiated in January 1950 by the Petroleum Products Branch of the Materials Laboratory, Research Division, Wright Air Development Center.

NEW DRY BATTERY

A durable and economical new battery developed by the Army Signal Corps will last twice as long as batteries now in use and utilize low-grade domestic manganese dioxide instead of the high-grade product now imported from the African Gold Coast. Manufacture of the new dry battery will be slightly more costly than old types, but substantial economies will result from doubled life and reduction in storage and shipping costs. At present, the armed forces use dry batteries in some 1,000 applications.

POWDER HAULING MADE *SAFER* BY FRUEHAUF ENGINEERING



FRUEHAUF
***Full Automatic* Supports**
add Safety—Save Time, Effort, Cost.

DURING World War II, Fruehauf and Army Ordnance engineers successfully developed the Full-Automatic, Cab-Controlled Van-Semi-Trailer for maximum safety and efficiency in moving explosive powder. Nearly 3,000 of these exclusive Fruehauf units were built. They received universal acceptance by both government and privately operated plants throughout the country.

An improved Fruehauf Powder Haul Van is now available. An outstanding example of Fruehauf engineering and manufacturing experience, it incorporates every possible special safety feature to eliminate human contact with the Trailer and minimize powder hauling hazards.

Hazards Minimized by these Special Safety Factors

1. All *interior body surfaces are of non-sparking non-ferrous metals.*
2. Interior walls and doors are lined with laminated wood fastened with brass screws.
3. The sturdy oak floor is fastened by brass bolts to a steel sub floor.
4. Maximum-opening full-width rear doors and optional side doors swing back parallel to Trailer sides for most efficient loading and unloading.
5. All outside panels are completely weather-lapped, and watersheds above doors prevent leakage.
6. All wiring is protected by conduit and weatherproof junction boxes and connections.

FULLY AUTOMATIC COUPLING

Coupling is completely cab-controlled. The driver simply backs the tractor under the Trailer, which locks the king pin and raises the automatic supports in one motion. There is no cranking.

FULLY AUTOMATIC UNCOUPLING

Uncoupling is quick, safe, and completely cab-controlled. The driver merely operates a hand lever inside the cab to disengage the king pin, then drives away. Supports are automatically lowered and locked in the down position.

FULLY AUTOMATIC CONNECTIONS

Lights and mechanical brakes are automatically connected through the hollow king pin during coupling, and automatically disconnected during uncoupling. Brakes are set automatically to prevent rolling when Trailer is uncoupled.

HUMAN CONTACT IS ELIMINATED!

THE DRIVER NEVER LEAVES THE CAB!

FRUEHAUF *Trailers* "ENGINEERED TRANSPORTATION"

Precision rifles

built for hard use

FINE RIFLES don't have to be delicate. Rifles of the Remington "500 Series," for example, can stand hard use from inexperienced shooters and still deliver thousands of rounds of accurate, trouble-free shooting.

The common causes of malfunction in 22 rifles have been overcome in the "500 Series." They have double cams, double-locking lugs and two sturdy extractors. Their stocks are made of American walnut, and every model has a deeply checkered butt plate.

Critical small-bore shooters are invariably pleased by the performance of the Remington "500 Series" rifles. Whether it's the low-cost single shot, Model 510; the box magazine repeater, Model 511; or the Model 512 with tubular magazine—the "500 Series" delivers years of accurate shooting at a surprisingly modest cost.

The rifle pictured above is the Model 513T, the aristocrat of the series. It has the same fine action as the others, plus a special heavy, 27-inch target barrel, target stock and other accessories.

Whether you buy for training beginning shooters, or for your personal pleasure, by all means see these and other fine Remington firearms at your dealer's. Remington Arms Company, Inc., Bridgeport 2, Conn.

Serving American Sportsmen since 1816

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of

"Confederate Handguns"

by

William A. Albaugh, III

• This article, which appeared in the November-December 1951 issue of ORDNANCE, is a revealing and authentic study of the design and manufacture of sidearms issued by the Confederacy. With 14 illustrations.

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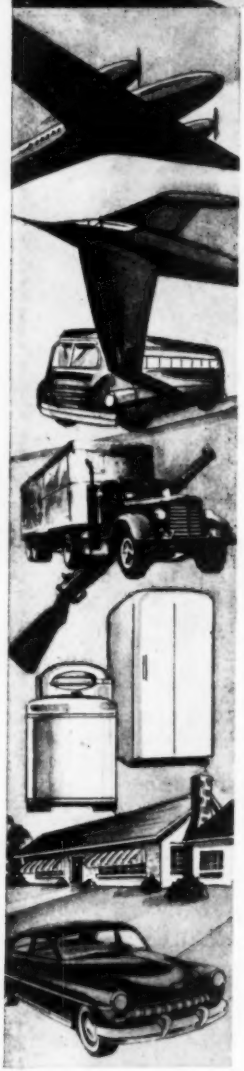

PAINT BONDING

"GRANODINE"® forms a zinc-iron phosphate-coating bond on sheet metal products—automobile bodies and fenders, refrigerator cabinets, etc.—for a durable, lustrous paint finish.

"LITHOFORM"® makes paint stick to galvanized iron and other zinc and cadmium surfaces.

"ALODINE",® the new ACP protective coating chemical for aluminum, anchors the paint finish and protects the metal.

RUST PROOFING

"PERMADINE",® a zinc phosphate coating chemical, forms on steel an oil-adsorptive coating which bonds rust-inhibiting oils such as "Granoleum."

"THERMOIL-GRANODINE"® a manganese-iron phosphate coating chemical, forms on steel a dense crystalline coating which, when oiled or painted, inhibits corrosion.

PROTECTION FOR FRICTION SURFACES

The oiled "THERMOIL-GRANODINE" coating on pistons, piston rings, cranks, camshafts and other rubbing parts, allows safe break-in operation, eliminates metal-to-metal contact, maintains lubrication and reduces the danger of scuffing, scoring, galling, welding and tearing.

IMPROVED DRAWING AND COLD FORMING

"GRANODRAW"® forms on pickled surfaces a tightly-bound adherent, zinc-iron phosphate coating which facilitates the cold mechanical deformation of steel, improves drawing, and lengthens die life.

Send for descriptive folders and Government specifications chart on the above chemicals. Write or call for more information on these products, and advice on your own metal-working problem.

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FROM THE RECORD

COMMUNIST CONSPIRACY

The international Communist conspiracy to overthrow freedom and democratic self-government is the greatest, the most sinister menace ever to confront mankind. It is so diabolical in its intent, and in the heartless methods employed to gain its evil ends, that men of good will never could have conceived it.

It is so tremendous in scope—for its goal is that of bringing all the lands and peoples of the world under the direct domination of the Communist dictators in the Kremlin—that the minds of ordinary honest men encounter difficulty in grasping the enormity of the Communist plot and in accepting the evidence of slavery reported daily from suffering millions in the Soviet Union and in the satellite slave states held in Red bondage.

Yet all this is true; all this has been spread before the eyes of the world for all to see and understand. And because free men have the faith and the courage and the will and the understanding of their peril they stand united today in defense of freedom.

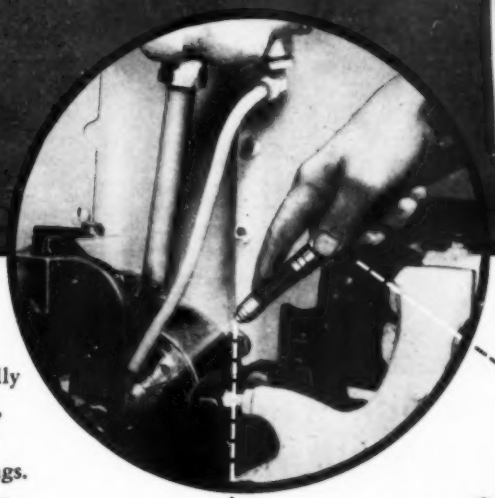
The free world stands united in defense of freedom because its free governments and its free peoples have learned through bitter experience that the only language the Kremlin understands and respects is the language of strength. We are determined to build and maintain the kind of strength it takes to make the Kremlin mind its own business—and nobody else's business!—UNDER SECRETARY OF THE NAVY FRANCIS P. WHITEHAIR *before the American Conference to Combat Communism, Milwaukee, Wis.*

NEW MATERIALS FOR WEAPONS

During the past decade many new weapons and pieces of equipment have been evolved that require strange and unfamiliar materials to achieve their unique performance characteristics. With science going increasingly into matters of defense, this is an inevitable trend.

World War II acquainted us with radar, electronic fuzes, jet aircraft engines, magnetic mines, tungsten-core shot, primitive types of guided missiles, atomic bombs, and many other lesser-known devices. Since then the science of war has by no means stood still. With the advent of these new weapons of war have come military requirements for many new materials that within our recent memory were only laboratory curiosities; for example, tantalum for capacitors, beryllium-bronze diaphragms, germanium for transistors, titanium as an alloy or

Speed Defense Production with HECO *Flex-Tip** AIR BLOW GUNS



Sturdy, Lightweight,
Streamlined, Practically
Indestructible. Plated,
Hardened steel nose.
No handles. No springs.
No levers. No triggers.
No push-buttons. No packings.
No leaks. Nothing to break,
Clog or get out of adjustment.
Has double the life of ordinary
blow guns.

FURNISHED IN STANDARD ¼" and ½" I.P.T.

Catalog No. A-1 (¼" I.P.T.). Individually boxed, 1 dozen in carton. Weight 2½ pounds per dozen. List $1.50 each. Discount to industrial users.
Catalog No. A-2 (½" I.P.T.). Individually boxed, 1 dozen in carton. Weight 3½ pounds per dozen. List $2.50 each. Discount to industrial users.

JUST *Flex* TO USE

SHUTS OFF INSTANTLY

Valve Open—Actual Size, A-1

Until blow gun is flexed, the entire air line pressure is on the valve assembly, forcing it against the valve seat and forming a perfect seal. NO LEAKS. NO LOST AIR. Simply flex to operate. Any desired amount of air can be obtained, from a gentle puff to a STRONG BLAST.

IMMEDIATE DELIVERY Wire, phone or write

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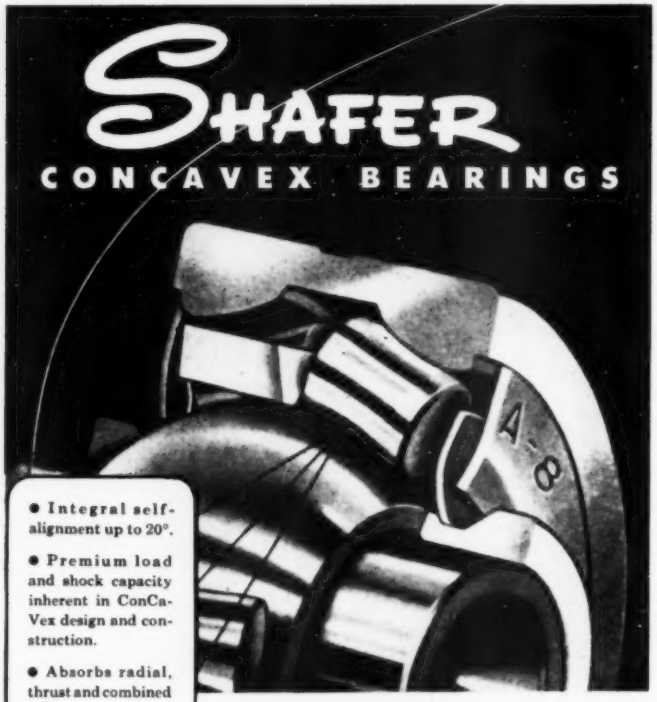
CONCAVEX BEARINGS



- Integral self-alignment up to 20°.
- Premium load and shock capacity inherent in ConCa-Vex design and construction.
- Absorbs radial, thrust and combined loads.

THE LIGHTWEIGHT HEAVYWEIGHTS FOR AIRCRAFT....

Shafer Bearings have long been waiting for aircraft demands to approach their ability for absorbing tremendous overloads and shocks. This explains the aircraft industry's steadily growing trend to "Shaferize" the vital control mechanisms of every type of air-borne craft—both commercial and military.

The basic ConCaVex design is an aircraft "natural." It provides high load and shock capacity, low friction and integral self-alignment together with space-saving, weight-saving compactness. This, combined with advanced engineering, precision craftsmanship and finest materials have, for 32 years, ranked Shafers as the No. 1 choice in aircraft control bearings.

Compare them. Test them. You'll find they surpass YOUR every expectation just as they surpass every rigid Army and Navy specification. Write for aircraft Bearing Catalog No. 50.

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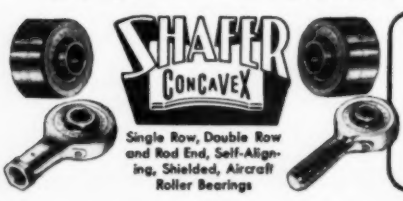


Single Row, Double Row and Rod End, Self-Aligning, Shielded, Aircraft Roller Bearings

The best in Industrial Bearings, too! Write for new Catalog No. 61.

metal, columbium for alloying, boron for steel making. All these materials are today highly essential to the production of principal weapons of war.

Design and material content are sometimes dictated by defensive considerations. Though we may hesitate to expend our strategic resources upon a protective device or defensive armor, the enemy and not we make this compelling decision. Military prudence demands that we must have in being an effective answer to every weapon that can be brought to bear against our troops or our cities.

Jet Requirements

The high performance characteristics required in the hot end of the jet turbine aircraft engine serve as a good illustration of the new materials requirements created by scientific advances. Temperatures are moving closer and closer to 4,000 degrees; there are corrosive gases, tremendous velocities, and centrifugal stresses; and there are dangerous consequences of minor failures. To meet these exacting conditions requires alloys of many different constituents: columbium, tantalum, titanium, cobalt, nickel, molybdenum, tungsten, and chromium. Iron in these parts is almost an impurity!

While new and unpredictable requirements for materials constantly arise, the requirements for basic industrial materials continue to increase. Armament grows heavier. Planes get larger. Firepower and expenditure of ammunition increase. Ever-larger quantities of metals and minerals are needed—copper and steel and zinc; manganese, lead, and tin.

The heavy bomber of today has doubled or even tripled over the weight of its World War II counterpart. That means two or three times as much steel, copper, and aluminum required for the construction of military aircraft needed in steadily increasing numbers.

This is particularly well illustrated by the fact that today's medium bomber requires half again as much aluminum as its earlier World War II heavy bomber counterpart. It is also significant that the World War II heavy bomber required half as much steel as a heavy tank. The heavy tank in turn requires more than 130,000 pounds of alloy steel.

A submarine requires 1,600 tons of steel, 300 tons of lead, 390,000 pounds of copper, and 13,000 pounds of aluminum. An aircraft carrier consumes more than 30,000 tons of steel, 1,300,000 pounds of copper, and more than 70,000 pounds of aluminum—but consider for a moment that the heavy aircraft carrier uses less aluminum than the World War II heavy bomber.

Consider the guns on the "Big Mo": to fire a one-minute salvo requires almost 100,000 pounds of alloy steel and 1,300 pounds of carbon steel. It uses more than

Skilled Hands keep the Armed Forces ahead

For well over a century International Harvester has built an ever-increasing variety of machines and equipment to serve agriculture, industry, and transportation.

Today, we are engaged in another vital activity in that same tradition: building equipment that helps put force behind the Armed Forces.

This ability to gear our production to the requirements of the Armed Forces is based on our fine staff of engineers, the meticulous and pace-setting manufacturing research we sponsor, our reputation for mass production of fine precision machinery.

The precision products we manufacture must meet tolerances measured in ten-thousandths of an inch. In some cases they are so fine that only light waves can measure them. Our operators have the skill and experience to use well the tools designed for such high precision work. And every piece of equipment is constantly inspected and re-inspected by finely gauged tools and against statistical charts.

When it comes to plus or minus 1/10,000 the responsibility is ours. This is the kind of responsibility that will help maintain the supremacy of the U. S. Armed Forces.

INTERNATIONAL HARVESTER

Glue-Bonded Coated Abrasives
Two Sources of Supply

While Resin-bonded Coated Abrasives are going to town for wet Sanding and the tough metal-working jobs, the demand for Glue-bonded Abrasive papers and Cloths has increased greatly.

We manufacture as complete a line of glue-bonded Aluminum Oxide, Garnet, Silicon Carbide, Emery, Crocus and Flint papers and Cloths as can be found Anywhere

We convert these into 50-yard rolls, Sheets, belts, discs, Sleeves, Mechanics rolls and many special Shapes.

Two Sources of Supply are a "must" today, with the existing uncertainties in deliveries and the Chance of tieups in transportation. Keen buyers know this.

May I send you Samples? I know you will like Clover products and our Service

E. B. Gallaher

If you are not receiving the Clover Business Letter, I will gladly Send it.

CLOVER MFG. CO., NORWALK, CONN.
Since 1903
Manufacturers of Clover Lapping and Grinding Compounds and a full line of Abrasive Papers and Cloths.

From the Record

two-thirds of a ton of copper and brass, and the labor required to produce a minute of fire amounts to more than 3,600 man-hours. There is enough steel in every medium tank to produce thirty new automobiles.

It would be a dangerous oversimplification, however, to speak in tons of steel, copper, and aluminum as the sum total of our military raw materials requirements. Quite the contrary is true, for, more importantly, the military end-item program necessitates specifications which require large quantities of critical and strategic minerals, such as nickel, cobalt, manganese, tungsten, and columbium, to mention only a few.

Tungsten Carbide

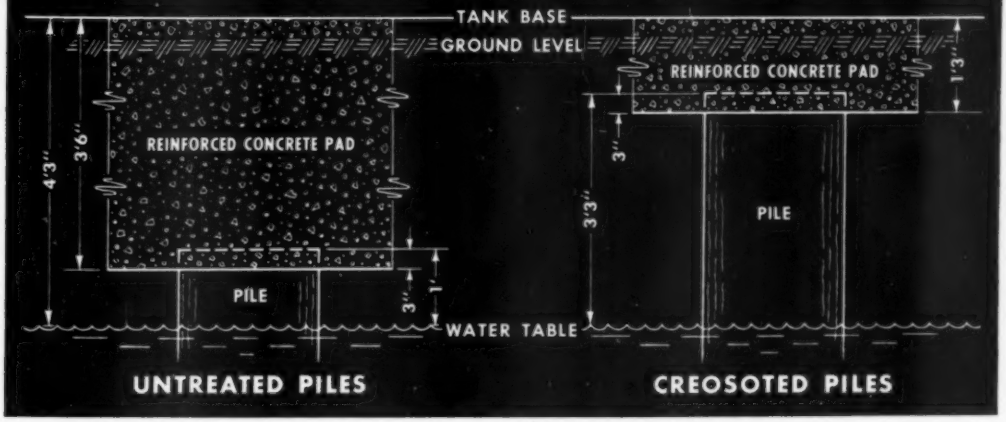
A single round of high-velocity armor-piercing ammunition for the 105-mm. gun requires eight pounds of tungsten carbide. Consider that only a few ounces of tungsten will make several miles of ordinary commercial lamp filament. When we include ammunition for heavy, medium, and light artillery; for antiaircraft artillery; for machine guns and small arms, the requirements aggregate astronomical quantities of individual rounds.

The work horse of our artillery, the 155-mm. high-explosive round, requires a 155-pound billet of alloy steel in the manufacture of a single shell; whereas 1,000 rounds of machine-gun ammunition use more than 340 pounds of copper, 100 pounds of alloy steel, and 10 pounds of lead.

Of the seventy-three materials currently on the national stock-pile purchase list, only eight are produced in any large quantity in the United States. This points up the necessity to maximize our supplies from abroad as well as from home. The latest listing by the Defense Production Administration of basic materials and alternates states that there are today 130 materials in critically short supply. Of these, 44 are metals, 9 are chemicals of mineral origin, and 18 are nonmetallic minerals.

In short, a one-sentence summary of our national mineral situation today is this: For the next four years, and probably for the next five years, the full production of all operating mines in the United States will be required to meet the needs of the military production program and essential civilian requirements, with as much as possible of certain critical materials reserved for the national stock pile. We will not have any lasting surpluses of any strategic or critical material in the foreseeable future.—ASSISTANT SECRETARY OF THE ARMY KARL R. BENDETSEN *before the American Mining Congress, Los Angeles, Calif.*

Alternate methods of supporting large storage tanks



$33,000 SAVED *by Founding 6 Tanks on Koppers Creosoted Piles!*

AT THE Williams Plant in Port Arthur, Texas, foundations were recently installed for six large storage tanks. These tanks are on ground that is slightly above the permanent water table. Under such conditions it is common practice to use *untreated* timber piles for foundations.

But *untreated* piles, as shown above, may require a *thick* pad of concrete—and that runs into real money. This thickness of concrete may be necessary because untreated piles cannot be cut off any higher than one foot above the permanent water table; otherwise they are vulnerable to decay and insect attack.

Koppers *Pressure-Creosoted* Piles, on the other hand, are fully protected against decay and insects... they can be cut off *at any point above the permanent water table.* A thinner pad of concrete is all that's needed—and the costs are much lower.

That's why the Williams' tanks were founded on Koppers Creosoted Piles. The estimated savings in material and labor, based on Gulf Coast prices, are set forth below. These figures cover all six storage tanks—five tanks with a capacity of 500,000 gallons each, and one tank with a capacity of 1,500,000 gallons.

Comparative Costs

UNTREATED PILES		CREOSOTED PILES
1,479	Number of Piles	1,320
35'	Length of Piles	35'
2,610	Cu. Yds. of Concrete	930
3'6"	Pad Thickness	1'3"
61.95	Tons of Reinforcing Rod	61.95
1,930	Cu. Yds. of Excavation	432
$180,850	Total Cost	$147,338

$180,850
147,338
Savings—$ 33,512

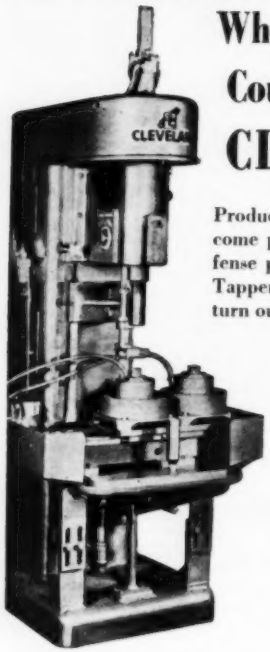
Use of untreated piles would have increased foundation costs by 22.7%.

Pressure-creosoted piles are now accepted in most modern building codes for permanent construction. Write for further information and quotations.

KOPPERS **PRESSURE-TREATED WOOD**

KOPPERS COMPANY, INC. · Pittsburgh 19, Pa.

CLEVELAND *lead* **tapping machines** *screw*

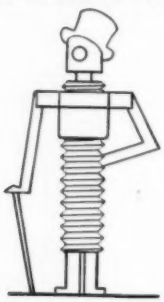


When Every Hour Counts...Rely on CLEVELAND

Production hours saved can become pretty important in a defense program...and Cleveland Tappers save production time... turn out more perfect pieces per hour. They cut tapping costs by combining operations...turn semi-skilled workers into skilled operators. Cleveland engineers can design a machine for your needs which will not only combine several operations but also tap groups of holes at one stroke of the machine. If you have a production problem check with Cleveland FIRST.

A CLEVELAND TAPPER set up on a munitions job, tapping a 1 15/32", 16-pitch Buttress thread in SAE 4143 steel tubing hardened to 35 to 37 Rockwell.

Meet Mr. Lead Screw



Cleveland offers all these features

- Precision hardened and ground lead screw.
- Fully automatic or manual control.
- Precision depth control for blind hole tapping.
- Heat treated alloy steel spindles for maximum strength.
- Easily changed spindle speeds.
- Exclusive super sensitive clutch reduces breakage and increases tap life.
- Positive coolant and lubricant supply under constant control of operator.
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Book REVIEWS

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The Forrestal Diaries. Edited by Walter Millis with the collaboration of E. S. Duffield. New York: The Viking Press. 581 pp. $5.

THE "diary" of James Forrestal, first Secretary of Defense of the United States, comprises notes which he kept from the middle of 1944 shortly after his appointment as Secretary of the Navy until he left office just before his last illness and tragic death on May 22, 1949.

The editor and the collaborator of this volume have interlarded the notes with comment and related fact, thus giving the text the continuity and perspective not otherwise always apparent. They have performed a painstaking service by their researches. At some future day when all the notes kept by the Secretary are made available the commentary thus supplied will be of even greater significance.

The public service of Jim Forrestal stands, for those who saw something of it at close range, as an inspiring thing, marked as it was by the shy demeanor of a very learned, tireless, and extremely honest man. The record of his contribution to the success of the United States Navy while he was its Under Secretary, and later Secretary, will stand unchallenged in the annals of that great arm.

It was to protect the Navy's important place in the maintenance of our sea power and at the same time to unify the land and air arms with it that eventually cost him his very life. The sacrifice, I dare say, was willingly made for, above all else, Jim Forrestal was a man of unflinching loyalty to principle.

In addition to all his other superior qualifications that loyalty as an uncompromising advocate of the best interests of our common defense will stand high on his epitaph.

Other reviewers have analyzed "The Forrestal Diaries" from varying points of view. I would like to stress two characteristics of the man which stand out boldly on every page.

The first has to do with the Forrestal sincerity of purpose. His devotion primarily to the common defense and secondly to the Navy is all the more stimulating when contrasted with the cheap political maneuverings of so many of his contemporaries in related phases of Government service. Thus his outspoken challenge at all times—Cabinet meetings not excepted—of the

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compromisers and the political hacks with whom he was compelled to mingle.

How he lectured those who put the best interests of the United States in second place! How he bluntly repudiated those who for personal, racial, or starry-eyed, one-world reasons were willing to scuttle our security in favor of an alien advantage! How he saw through the fallacy of the Morgenthau Plan for the dismemberment of Germany! These and other dubious policies he challenged at every turn of the way.

The second major characteristic of the "Diaries" is the dilemma that stands forth on nearly every page. Here was an American of superior intelligence, of deep patriotic fervor, of broad experience in industry and finance, of profound classical education who came at his country's call in emergency to serve as best he could and who remained to untangle the aftermath of the greatest of wars.

In the problems of unification of the services he encountered his greatest challenge; he accepted it and met it. The price he paid was his very life as gloriously as if he had fallen in the Battle of the Bismarck Sea, at Bastogne, or at Ploesti.

The great dilemma posed by Jim Forrestal's diaries is: When will the little men in public service be repudiated so that big new men—men of the Forrestal honesty, patriotism, and background—can offer their services to their country with some fair assurance that their love of truth will not bring character assassination and even death?—Leo A. Codd.

Clear the Decks. By Rear Adm. Daniel V. Gallery. New York: William Morrow & Company. 236 pp. $3.50.

If you write an autobiographical book, you cannot avoid baring your true character to all who read it. That fact is particularly true in Admiral Gallery's book, "Clear the Decks." In addition to being a series of closely related, exciting yarns, upholding the best traditions of the Navy, it also is a clear-cut picture of the man who wrote the book and made the history which it relates. In a one-word definition, the same thing that makes a ship great, makes a man great. It is "character."

Throughout the series of yarns which make up the book, the reader sees Admiral Gallery as a brave man, with a brave man's knowledge of moments of fear; as a human being and a true leader who leads by ability as well as by the affection in which he is held by those under his command.

And what a lusty yarn the Admiral spins! From his spoofing of the English in Iceland to his "bring-'em-back-alive" exploit in boarding, capturing, and towing to Bermuda a German submarine, it is a

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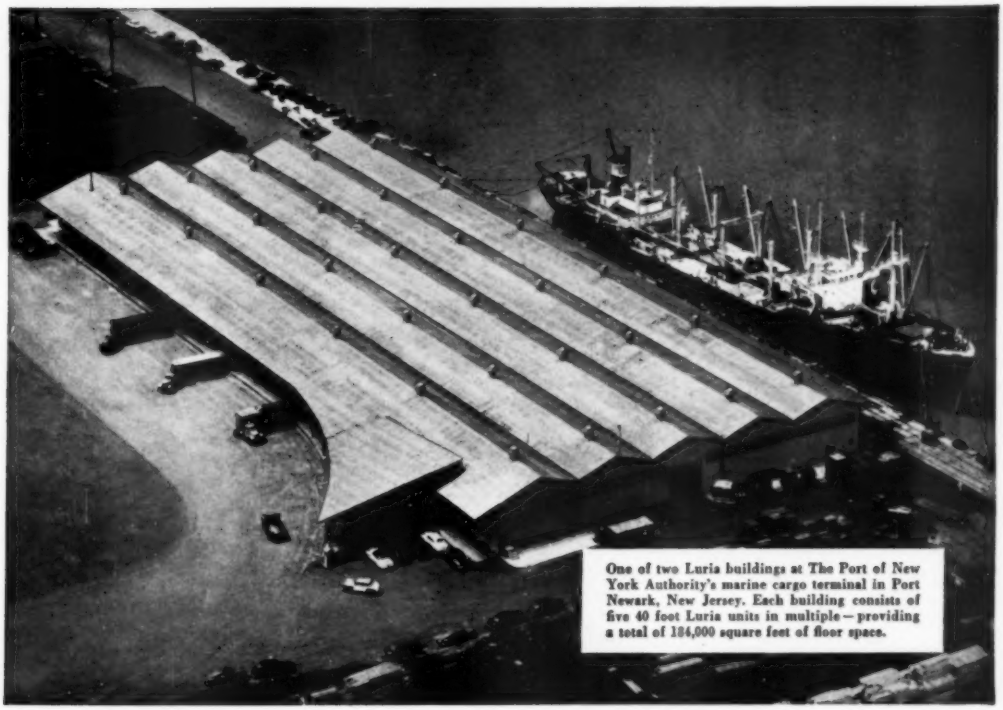

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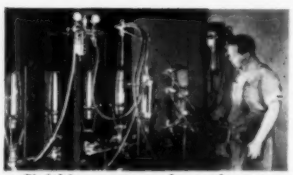
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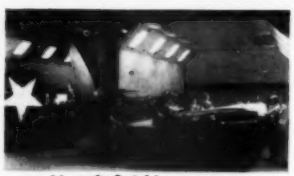
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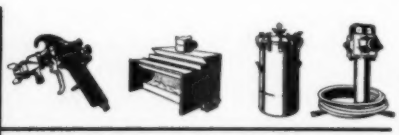

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thrilling adventure story, simply and believably told. It carries the ring of authenticity, which only a writer who has "been there" can achieve.

"Clear the Decks" is as salty as the Admiral himself. It is proof of the fact that truth is not only stranger than fiction, but also, in the able hands of a seafaring adventurer, much more exciting and inspiring.—CLARENCE CISIN, *Comdr., U.S.N., Office of Public Information, Department of Defense.*

Bringing Up The Brass: My Fifty-Five Years at West Point. By Sgt. Marty Maher. New York: David McKay Company. 234 pp. $3.

AMERICAN literature today when it deals with the armed forces is filled with books by disillusioned ex-soldiers and sneering civilians with their carping criticisms of all things military. The "brass" for the most part has come off badly. The exceptional and the unusual has been portrayed as the typical. The average reader has gained a warped and distorted picture of the Army.

Consequently it is almost incredible when an old soldier describes his life at West Point, expressing enthusiasm for his years at the Academy and for the cadets who later became our military leaders.

Sergeant Marty Maher is a jolly extrovert who thoroughly enjoyed his part in the physical training of cadets at West Point. He communicates his happy memories of a long life from "the little people" in Ireland to the big brass of the Army. His style is jovial and sprightly, and he tells many anecdotes about the military great and near-great that impart better understanding of life at West Point.

As General Eisenhower points out in his foreword, West Point celebrates its 150th anniversary in 1952, and Marty Maher was an important part of it for over 50 years. He adds that "every West Pointer will read his tale with avid and nostalgic interest."

The nongraduates who have the good fortune to read this amusing autobiography will be royally entertained by this Irish sergeant whose gusty sense of humor puts the tribulations of a soldier's life in their proper perspective.—DONALD ARMSTRONG.

Civil Defense in Modern War. By Augustin M. Prentiss. New York: McGraw Hill Book Company. 417 pp. $6.

GENERAL PRENTISS, a retired officer of the Chemical Warfare Service, has probably spent as much time as any one in the United States in thinking of defense against weapons. He served in the Chemical Warfare Service for almost thirty

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Rockwell Report

by W. F. ROCKWELL, JR.
President
Rockwell Manufacturing Company

ONE OF THE MOST SATISFYING REWARDS of being a part of a business management team is in watching a Company grow.

Of the many ways to measure corporate growth—assets, number of employees, sales, manufacturing area and so on—one that is often overlooked is number of stockholders. When a company's ownership spreads, the responsibilities of the management increase.

Like most companies, the Rockwell Manufacturing Company started with only a few stockholders. As the Company has expanded its markets and as the demand for our meters, valves, tools and other products has grown, the ownership has also spread. As recently as 1945, there were fewer than 1,000 stockholders of the Rockwell Manufacturing Company while today there are more than 7500. A great many, by the way, are employees.

Perhaps in that spreading ownership there's an answer to those who would have you believe that the earnings of industry find their way to the pockets of a very few. When a relatively young and still relatively small company such as ours, just in the process of normal growth becomes the property of so many people, it's reasonable to assume that there are a vast number of Americans who understand that no business is successful unless it provides a good product at a proper price to its customers, a fair return to employees and stockholders, and a reasonable profit to its suppliers.

* * *

Our Delta Power Tool Division is one of the principal builders of wood and metal working tools for school shops and vocational education. To improve teaching facilities and aid school architects in laying out shops that will not only provide for today's enrollments, but also be adaptable to school growth, Delta is now sponsoring a contest among school men on efficient shop layouts. Winning plans will be discussed at the next convention of the American Vocational Association, and all of the better layouts for all types of schools will be published by Delta for distribution to school planners, boards of education, administrators, etc.

* * *

In our several divisions that manufacture meters, we make a good many types that you see in your day-to-day activities—gas meters, water meters, gasoline meters, parking meters, taxi meters, etc. Not so well known to the general public are the Rockwell meters that are used in hundreds of industries to measure the component parts of an end product. As an example, the A. B. Dick Company, in making mimeograph and other inks uses Rockwell Rotocycle meters to measure ether, alcohol, paraffin, ethyl glycol, rosin oil, red oil, castor oil, span 80 and rocket H. Many other processing plants use similar meters for all sorts of batching and blending operations.

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One of the advantages of a company set up such as ours is the opportunity for internal sub-contracting. Under the direction of our headquarters staff, work is allocated to the plant best equipped to handle it. There are many benefits. Standardization is encouraged. The customer benefits from lower costs. Employment is stabilized. Facilities are kept busy. Total output is increased. Local material supplies can be utilized.

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Book Reviews

years, largely during the period when that service was restricted to defensive planning.

The first part of his book contains a review of the characteristics of modern weapons which may be used in aërial bombardment against civil communities, including atomic, bacterial, and chemical types. He stresses the importance of incendiary, chemical, and biological weapons, all of which are responsibilities of the Chemical Corps. He does not neglect TNT entirely, and he uses much space in describing atomic weapons.

His information concerning bacterial and atomic weapons is obtained from magazines and books which have already been published. The sections on bacterial agents are especially valuable.

The second part of the book covers methods of protection, and the third part discusses organization for civil defense. Considerable attention is paid to the experiences of the British during World War II. However, since both the Germans and the Japanese had much civil-defense experience against aërial bombardment, the book perhaps should have included in the bibliography some reference to their civil-defense regulations.

At this time we are all being told that we must be prepared to defend our cities against aërial bombardment. There is much official and other instruction being published on the subject, but General Prentiss' book stands out. I do not mean that his book is accurate in every respect, but if you want to get a rounded, not-too-technical picture of a large part of the civil-defense problem, this is the book to read.—PHILIP SCHWARTZ.

The U. S. Marines And Amphibious War. By Jeter A. Isely and Philip A. Crowl. Princeton: Princeton University Press. 635 pp. $7.50.

THE very name of the Marine Corps connotes amphibious operations. From its establishment in 1775, patterned on its British prototype whose motto is, appropriately, "Per Mare, Per Terram," Marine participation in landings of American forces upon hostile shores has been practically taken for granted.

So it will be no news to those at all familiar with Marine Corps history to read in Isely and Crowl's volume that the Devil Dogs never did subscribe to the widespread belief held after the Gallipoli fiasco of 1915 that "large-scale amphibious operations against a defended shore, especially if conducted in daylight, were almost certain to be suicidal."

Instead, they proceeded wholeheartedly with the development of the idea of an "advanced-base force" which had been evolved by the General Board of the Navy

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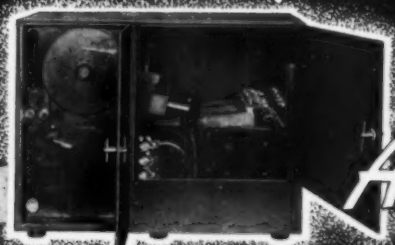

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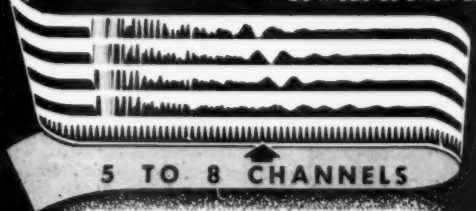

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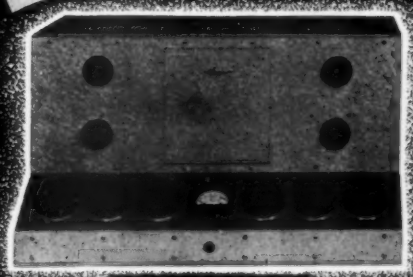

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shortly after the Spanish-American War. (Dewey at Manila had found himself severely handicapped by lack of sufficient Marines to constitute a landing force.)

This finally led, in December 1933, to the official establishment of a "Fleet Marine Force," evidence that "the Marine Corps had finally and unequivocally committed itself to the doctrine that its paramount mission in wartime was to serve the fleet by seizing bases for naval operations and in peacetime to prepare for the successful execution of that function."

In 1934 the Corps produced its "Tentative Landing Manual" which was adopted by the Navy in 1938 and the Army (in large part) in 1941. And it single-mindedly carried forward its amphibious warfare studies by developing detailed plans for the capture of various advanced bases in the Pacific (1935-1939). Nor did it confine its activities to theorizing. Actual "fleet landing exercises" were commenced on a small scale in 1935 and repeated annually at a gradually rising tempo up to our entry into World War II.

Army elements participated in 1938, but an invitation to repeat such participation in 1940 was declined on the grounds of "impracticability." In 1941, with war imminent, a "Joint Training Force" was established, and the combined training of Army, Navy, and Marine contingents undertaken.

And so, thanks to the farsightedness and enterprise of some men in olive-green uniforms, or stated differently, "with the help of God and a few Marines," early Japanese successes in the Pacific were later neutralized.

The authors take us and their hard-bitten Marines in turn to Guadalcanal and other islands of the Solomons, to New Britain and New Guinea, Tarawa, the Marshalls, Palau, the Philippines, Iwo Jima, and Okinawa.

Indeed, they lead us into every action into which Marine forces were substantially committed throughout the entire war in the various Pacific theaters and touch upon so many other collateral events and activities by land, sea, and air that one almost comes to feel that he is reading an over-all account of World War II operations in those areas—from Guadalcanal onward.

The book closes with an 11-page chapter on "Amphibious Progress, 1941-1945," which glances into the future and speculates upon modifications of amphibious tactics which may be in store. It warns against complacent acceptance of current practice as incapable of improvement; likewise against the idea that atomic bombs may make future amphibious operation too costly or air drops render them unnecessary.

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erences and a 10-page index terminate this carefully researched and pleasingly written volume which should prove a welcome, indeed a required, addition to the library of the serious student of military history.—CALVIN H. GODDARD.

Handbook of Dangerous Materials. By N. Irving Sax. New York: Reinhold Publishing Corporation. 848 pp. $15.

THIS huge book is something for the select few. It shows evidence of much research work on the part of the author, and it should be useful to the safety engineers of big companies handling a multitude of chemicals, though its 5,000 listings are not limited to industrial chemicals, but include such items as poison oak, etc.

As with all books on subjects relating to human medicine, the volume could be dangerous itself in the hands of an enthusiastic amateur. The term "dangerous" is relative, and one could easily drive himself into a state of neurosis with a fearful searching into all vague symptoms.

All in all, however, the book should be a useful reference for the competent safety engineer who will use it wisely. The 222 pages of shipping regulations form a valuable compilation for those who have to handle chemicals and hazardous materials.—GEORGE S. BRADY.

Herbert H. Dow—Pioneer in Creative Chemistry. By Murray Campbell and Harrison Hatton. New York: Appleton-Century-Crofts, Inc. 168 pp. $3.50.

THIS is an account, in nontechnical terms, of one man's share in the founding of a company and, in a way, of an industry. Herbert Dow was one of the pioneers of the American chemical industry. One of his first efforts in the 1890's involved the invention of an entirely new method of extracting bromine from brine.

Mr. Dow had two long struggles: One was to wrest from nature some of its chemical secrets; the other was to survive the commercially murderous tactics of powerful foreign combines which had monopolized the chemical field in the United States. His talents created many chemical processes and products until he had built one of the giants of the chemical industry.

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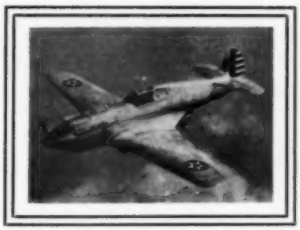

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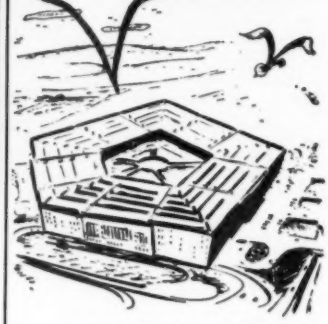

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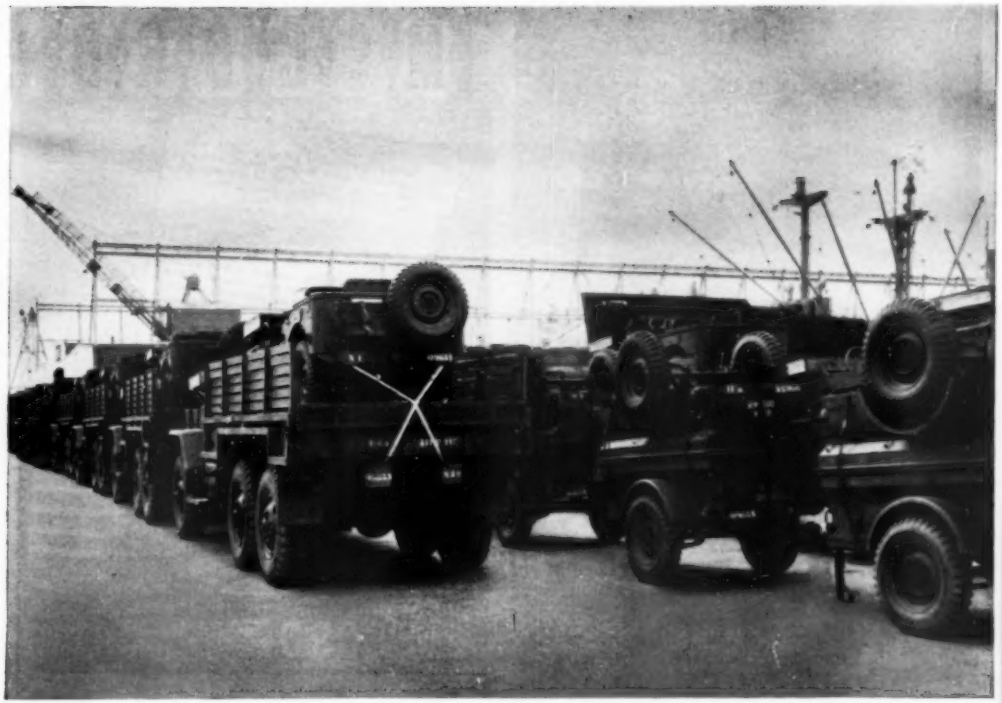

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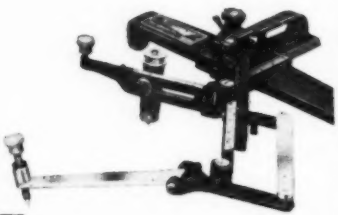

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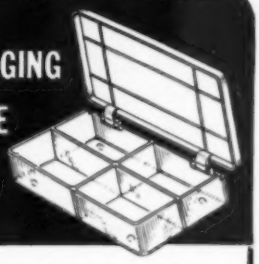

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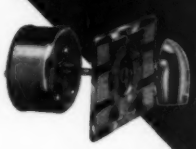

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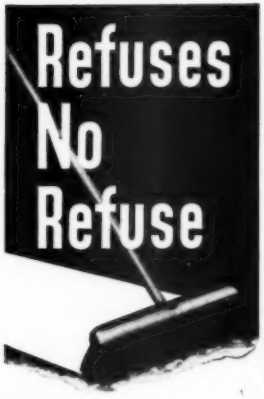

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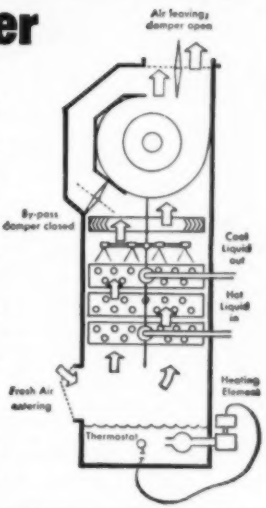

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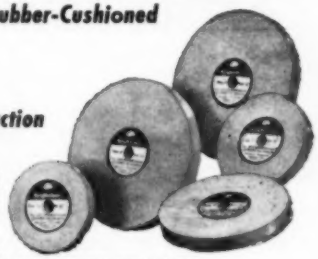

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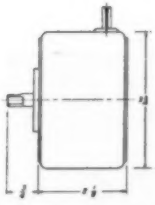

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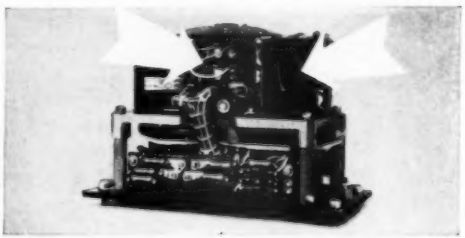

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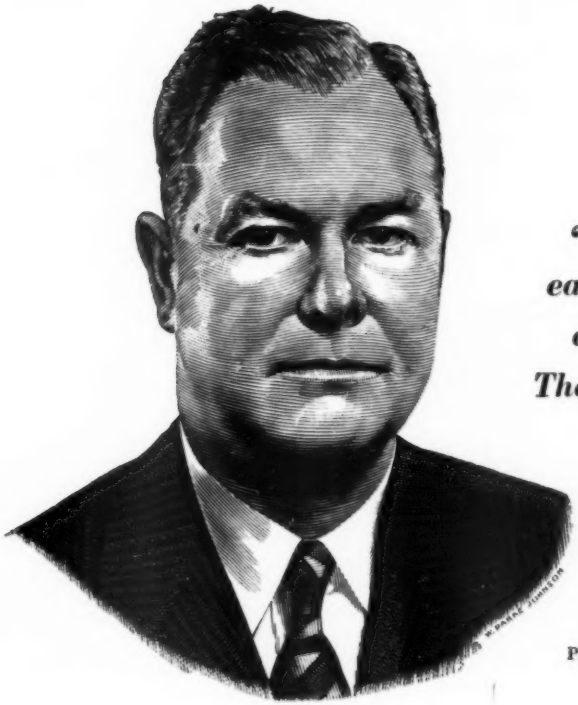

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ARMAMENT TECHNOLOGY

This section of ORDNANCE contains articles of a detailed and technical nature on ordnance research, development, manufacture, field use, and related subjects.

Rocket Propellants

Scientists Still Seek the Ideal Missile Fuel

Dr. John D. Clark

Chief, Chemical Section, Naval Air Rocket Test Station, Lake Denmark, N. J.

IN both developing and manufacturing rocket propellants, numerous properties must be considered. The first is, obviously, performance. This is usually measured in specific impulse, or I_{sp}, with the dimension of seconds. It is, briefly, the number of seconds for which a unit mass of a given propellent combination could, ideally, exert a force equal to that mass. For the propellants now known and used, this specific impulse runs from 200 to 350 seconds. If I_{sp} is multiplied by the acceleration of gravity (32.2 ft./sec.^{2}) the result will be the exhaust velocity of the jet in feet per second.

Equation Given

The specific impulse is related to the energy of the reaction involved by the equation:

$$I_{sp} = 6.95 \sqrt{AH/M\ \eta}$$

where H is the heat of reaction (in BTU's) per pound molecular weight of the reactants, M is their molecular weight, 6.95 is a constant including the conversion factor from thermal to mechanical energy, and η is the efficiency.

There are a good many methods of calculating η, none of them completely satisfactory. They would probably be a good deal better if, first, we knew exactly what happens inside a rocket chamber and, secondly, if our mathematics were equal to coping with the processes involved. However, the methods available at present are capable of calculating the specific impulse within a few per cent, and are good enough to tell us, at least relatively, what fuels are likely to give good results.

We know that a high chamber pressure generally increases the efficiency and that a high exhaust pressure decreases it. We know that a low average molecular weight of the exhaust gases increases the efficiency. Water, with a weight of 18, is a better exhaust gas than is carbon dioxide with a weight of 44. A low molecular heat capacity (C_p) of the exhaust gas aids the efficiency, which means that the simpler the structure of the exhausted molecule the better.

Helium would be a magnificent exhaust gas; carbon tetrachloride would be a remarkably bad one. The simplest and lightest molecule conceivable is atomic hydrogen (until that glorious moment when somebody dreams up a way of ejecting electrons and positrons, or even neutrinos, in a jet) and the next lightest is ordinary molecular hydrogen. Carbon dioxide is a relatively complicated molecule with a rather high heat capacity, and water isn't much better.

Propellent Combination

The result is that we tend to select a propellent combination which contains as much hydrogen and as little carbon as possible. We are likely to work on the rich side of the mixture, that is, with insufficient oxidizer to react with all of the fuel, so that an appreciable fraction of the carbon present oxidizes only to CO and there is considerable amount of free hydrogen in the exhaust.

These considerations more or less limit us, in our choice of propellants,

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New powerful wheeled vehicles

to compounds derived from the elements of the first part of the periodic table:

H
Li Be B C N O F
S Cl

As a result, a fuel is generally either hydrogen or a combination of hydrogen with one or more of the other light elements, while an oxidizer is a loose combination of oxygen or fluorine with the light elements or the free-oxidizing elements themselves.

Typical Fuels

Typical fuels, then, either used or considered, would consist of such compounds as ammonia, NH_3, hydrazine, N_2H_4, diborane, B_2H_6, and of such organic compounds as hydrocarbons, alcohols, amines, ethers, and so on. Oxidizers are such things as concentrated nitric acid, HNO_3, hydrogen peroxide, H_2O_2, pure liquid oxygen, O_2, and so forth.

Once a propellent combination has been chosen (by its performance, not merely by its heat of reaction) there are many other things to consider. One of these is the starting characteristics of the combination. Certain pairs, such as alcohol and liquid oxygen, must be ignited. This leads to complications and extra weight, particularly if the motor is designed to be turned on and off several times during a run.

Other combinations, such as aniline and red fuming nitric acid, are called "hypergollic," and ignite spontaneously when the fuel and the oxidizer meet. This is, obviously, a highly desirable property, but not without qualification.

Possible Dangers

Such a combination is excellent—if it ignites immediately. If it lingers awhile, if there is any appreciable ignition delay, there will be trouble. The fuel and oxidizer spray into the chamber, collect there in a puddle, and *then* ignite all at once, with results that are likely to be spectacular and disastrous.

There are similar difficulties with monopropellants, which are propellants which combine the fuel and oxidizer in a single fluid, either as a chemical combination or as mechanical mixture.

Mechanically, the monopropellant is an excellent idea, simplifying the design, requiring only one set of fuel tanks and pumps, needing only a simple injector, and with all the other obvious advantages.

Unfortunately, nobody to date has managed to prevent the reaction from moving up from the chamber to the fuel tank, with deplorable results.

Another thing that the engineer must consider is the temperature of the reaction. Some combinations burn at temperatures a thousand degrees higher than do others, and since the motor must be built of something with a finite melting point, that fact must not be forgotten.

The usual means of cooling the chamber walls is to pass the fuel, or oxidizer, or both, over the outside of the chamber before injection. This so-called "regenerative cooling" has a good many advantages. The chamber walls are kept below their melting point, and the heat lost through them is salvaged by the propellant and brought right back into the chamber through the injector. With a properly designed motor, true adiabatic conditions are approached, and the efficiency approaches the theoretical maximum.

Heat Capacity

But the heat capacity of the fuel must be considered as well as its thermal conductivity and its stability under the temperatures attained. If it decomposes appreciably under these conditions, either the cooling passages will be clogged up with the decomposition products, or the whole motor will explode.

Under any circumstances, the stability of the propellant cannot be ignored. A high-energy fuel or oxidizer, by definition, has a tendency to decompose. If that tendency is encouraged by mechanical shock, by immoderate temperature conditions, by catalysis of some sort, or, as is generally the case, by causes unknown, the results can be disconcerting.

Liquid acetylene has a lot of energy in it, but nobody in his right mind would care to use it as a rocket propellant. Similarly, while nitroglycerine has been proposed as a monopropellant, there has been an understandable reluctance on the part of the engineers concerned to initiate any considerable experimental program with it.

An extremely important consideration is the density of the propellant. Liquid hydrogen is, energetically, one of the best possible chemical fuels. But its density is approximately one-fourteenth that of water, and any reasonable amount of it will take an unconscionable amount of tank space. That means more dead weight and trouble in general. If you are designing a small missile to operate in the atmosphere, it will mean more air resistance and a lower performance of the missile itself.

Other Properties

Other physical properties must be considered. It can be assumed, by definition, that the propellants of a liquid-fueled rocket must remain liquid over the operating range of temperatures and pressures, and it must be remembered that a rocket does not run in a thermostat. The outside temperature, and hence that of the propellants, may vary from 60 degrees below zero Fahrenheit, to 140 above.

If the propellant freezes solid, or becomes too viscous for the pumps to handle when the rocket is at 50,000 feet, the flight is likely to come to a premature halt. If it boils off as the missile is taking off from the surface of the Mojave Desert, the feed rate is going to vary in a highly unpredictable manner.

Occasionally, pressurizing the fuel tanks is an acceptable answer. Butane, to mention one conceivable fuel, and chlorine, to mention an oxidizer, can be liquified at room temperatures by the application of quite moderate pressures. But in this case, and sometimes with propellants that are normally liquid, the vapor pressure of the material can cause trouble by inducing cavitation in the fuel pumps, vapor locks in the lines, and so on.

Liquid Hydrogen

Liquid hydrogen, with much to recommend it, is an extreme example of the difficulty of working with liquid "permanent" gases. Its boiling point is not only extremely low (second only to that of helium), but at low temperatures the molecule changes from the ortho to the para state, evolving heat and accelerating the evaporation. Even methane (CH_4), which would make an excellent fuel, would have to be handled like liquid hydrogen or oxygen, since no conceivable pressure can liquefy it at room temperatures.

Merely compressed gases are out of

the question. They require heavy tanks, which means more weight, and the density of even the most highly compressed gas is too low to permit an adequate amount of fuel in a tank of reasonable dimensions.

There is another consideration that presents itself. The propellant must be stored, perhaps for a long time, in some sort of a container, and it must be kept in the tanks of the rocket. Some of the best oxidizers, such as white fuming nitric acid, approach the legendary universal solvent in activity.

They are more likely than not to attack the storage drums, eat holes in the fuel tank, and to abolish the pump unless the material for these objects is chosen with more than ordinary care.

Other propellants, such as hydrogen peroxide, tend to decompose, and the decomposition may quite easily be catalyzed by some metal which we would like to use for the fuel tanks. Occasionally peroxide will start to decompose on its own, for no apparent reason. The decomposition liberates heat, which accelerates the decomposition, which liberates more heat, and so on, usually ending in a first-class explosion.

Under any circumstances, the material must be vented at all times to avoid the chance of a pressure build-up. Liquid oxygen, too, must be vented, and is extremely difficult to store for any length of time.

Answer Not Obvious

In general, however, the storage problem can usually be solved in a more or less satisfactory manner, and it usually is not entirely beyond the wit of man to choose structural materials that can contain the propellants, but the answer in any given case is not always obvious.

The propellant must be handled. Somebody has to transfer it from the storage container to the tanks of the rocket, and he frequently has a phenomenally unpleasant job on his hands. Red or white fuming nitric acid can start a fire if either one splashes on anything combustible. The fumes (NO_2) given off by the red acid are about as dangerous as phosgene, and liquid NO_2 itself has been considered.

If either acid touches the skin it will produce a very nasty burn, and it corrodes almost anything that it touches.

Concentrated hydrogen peroxide isn't particularly corrosive, and its fumes are merely oxygen and water, but it will ignite with many combustibles, including wool. More than one operator has been killed when a big spash of the material on his clothes converted him into a flaming torch.

"Briefly, there is no all-purpose propellent combination. The problems involved in a moon-ship are quite different from those involved in an antiaircraft missile."

Aniline is extremely poisonous and is absorbed through the skin. A big splash of it, if not removed immediately, can lead to cyanosis and death.

Liquid oxygen by itself is relatively innocuous, although it can freeze a hand quite solid quickly enough. However some of it, combined with an inflammable substance and a spark, can produce a serious explosion.

"Logistics"

Then we have the considerations covered by that much-abused word, "logistics." Let us assume that we have chosen a really good propellant. Can we get it when we want it and as much of it as we want?

The case of aniline and its homologues, now considered obsolescent fuels, is pertinent. Aniline is a fairly good work-horse fuel. It ignites well, has a good density, a fair impulse, good storage properties, and not too difficult handling characteristics.

But, it is made from benzene, and in the course of a major war there is never enough benzene available for half of the things that we would like to make from it. So, we cannot rely on benzene if we want to make a million missiles.

And the final consideration is the vulgar one known as money. If we are building a rocket to go to the moon, or one designed to convey an atomic warhead from Fairbanks, Alaska, to the spot where it will do the most good, price may very well be no object. But if we want to build seven hundred thousand missiles to be used to break up bomber formations, the price is something that cannot be entirely ignored.

Briefly, there is no all-purpose propellent combination. The problems involved in a moon ship are quite different from those involved in an antiaircraft missile. In the former case, performance is all important; in the latter, ease of manufacture, storage, and handling might well be so important as to make a slight loss of performance perfectly acceptable.

Ideal Characteristics

But even if the ideal propellant does not exist, its characteristics have been laid down by wishful engineers, and they are listed below for the benefit of prospective purveyors without any expectation on the part of the writer that a propellent combination with these properties will be immediately forthcoming:

1. Specific impulse, at least 350 seconds;
2. Hypergollic, with ignition delay of no more than 10 milliseconds;
3. Liquid range at atmospheric pressure from minus 60 degrees to plus 60 degrees Centigrade;
4. Low vapor pressure and viscosity;
5. Temperature-stable up to 500 degrees Centigrade;
6. Completely shock-stable;
7. High heat capacity and conductivity, approaching that of water;
8. Density at least 1.5;
9. Noncorrosive against aluminum and its alloys and against mild and stainless steel;
10. Nontoxic, and simple to handle;
11. Available in large quantities, without drawing on critical materials; and
12. Available at a reasonable price.

A propellent combination with the above properties would convince the rocket engineers that the millennium had arrived, but until the chemical manufactures of the United States produce something remotely resembling it, rocket design will be shackled to the unsatisfactory propellants that are now available.

The opinions and assertions contained in this article are those of the writer and are not to be construed as official or reflecting the views of U. S. Naval Air Rocket Test Station, the Navy Department, or the naval establishment at large.

Postmortem on Rifle Calibers

Some Reminiscences on Small Arms and Ammunition

by

Col. Charles G. Mettler

The present British trend toward a new light rifle brings back similar Ordnance anecdotes about weapons and projectiles

THE recent conversations about the caliber and character of the rifle to be supplied to the North Atlantic Pact nations has brought to mind other controversies and arguments that should be read into the record for the entertainment and guidance of the Ordnance officers concerned with the new decisions.

There is a long history of experiment and research that led the U.S.A. to adopt the caliber .30 for its rifle, particularly the work which preceded the adoption of the various bullets for battle targets—the light bullet, the heavy bullet, the armor piercer, the boattail, the long point, and such variations that have been tried and discarded along the alleys of experiment.

Serious Struggle

These few incidents in which I participated will serve to illustrate how seriously we struggled with the matter.

In 1914 I was alone in the Gun Division of the Office of the Chief of Ordnance in the old State, War, and Navy Building when several officials of the Newport News Shipbuilding Company came in and advised me that they had a great secret to reveal. They asked that the civilian secretaries be sent out. When the room was clear, they told me of their long experiments behind screens with a small-arms bullet that had shown them a decided improvement in range and accuracy. They unwrapped their drawings showing a tapered tail on a caliber .30 bullet and showed several comparative targets with standard and boattail ammunition.

Similar Reports

I happened to have on my desk at that moment two large, folded, endorsed letters from Sandy Hook Proving Ground covering our own experiments with the boattail, and I handed to them these reports while I looked at their results. The two were almost similar reports, but the Sandy Hook reports concerned artillery shell.

Other papers were available on small-arms experiments. There were also letters from inventors in considerable number suggesting the same experiments. I thanked them for their information and we had a good laugh and a lunch together.

In 1916 I organized the various ordnance functions in Hawaii, assuming charge of the armament district, the depot, and the Department Ordnance Office. As soon as I opened the doors for business, nearly all the company commanders landed in the office with complaints about the corroded small-arms ammunition, practically unusable for either rifle or machine-gun practice.

About six million rounds of caliber .30 ammunition were hauled out and found corroded in their bandoleers and clips beyond any effective battle use.

We set up three big kettles, put the cartridges through alkaline solutions and hot washings, washed the bandoleers, and sent out our product for tests on the ranges. After good reports, we recommended the cleaning of all the remaining lots, which was authorized, and also the packing of all tropical-use small-arms ammunition in hermetically sealed containers, which also was done.

The Pedersen Device

After World War I the great secret of the Ordnance was the Pedersen device by which the Springfield rifle was converted to a smaller caliber, rapid-fire, short-range arm with great firepower. This led to much thought about a smaller caliber rifle. Pedersen brought out a new semiautomatic shoulder rifle of caliber .276—a lighter arm with a mild "kick." It made a great hit at Camp Benning, then being developed as the Infantry School.

Brig. Gen. John T. Thompson, a retired Ordnance officer, brought out the Thompson submachine gun with caliber .45 pistol ammunition—a very effective light weapon. He also produced a semiautomatic shoulder rifle on the same principle.

J. C. Garand was employed at Springfield Armory to round up the semiautomatic arm situation and see what could be done to produce a good light infantry weapon. He produced a splendid rifle in caliber .276 and in caliber .30 for test.

Inventors Interested

In 1926 I was sent to London and found all the European inventors interested in our search for a new light semiautomatic arm, and they were seeking some of our caliber .30 and caliber .276 ammunition to try out their inventions, pressing their requests on my new office.

A while later I was invited to have a private chat with the Under Secre-

Colonel Mettler, now retired, held positions of high responsibility in the Ordnance Department for many years, some of which were: professor of ordnance and gunnery at the West Point Military Academy, military attaché in London; and commander of the Aberdeen Proving Ground, Md. He is now an active member of the A.O.A. in Florida where he is taking a particular interest in the new Florida Post.

tary of State for War in his office. When we got to the real subject of the chat, he told me that he had been informed that my Government had adopted the Thompson semiautomatic shoulder rifle, later he believed it was the Pedersen, but that we had positively adopted a smaller caliber.

Much Concerned

I assured him that he had been misinformed, that we would not adopt any of the existing semiautomatic rifles, and that we expected to test many before adopting any type or making any change in caliber. He said he was much concerned over our two nations adopting different rifles, or different ammunition, as he considered it most likely that we would have to battle again side by side in Europe in the not-too-distant future.

The matter of complication of manufacture and supply did not seem to worry his army officials as much as it should, and he said he would be most happy to have me press everywhere possible for uniformity of arms and ammunition in our two military organizations. He assured me that he would do so.

New Rifles Sought

The next summer when I was in Switzerland purchasing special rifles and firing locks for our International Rifle Team I received notice from the Chief of Ordnance to be on the lookout for new semiautomatic shoulder rifles for a test we would soon conduct in the U.S.A. I found such rifles under design and experimental test in Milan, Italy; St.-Étienne, France; Liége, Belgium; Brno, Czechoslovakia; and in Copenhagen, Denmark.

I asked those concerned to prepare their rifles for our tests with our ammunition and offered to get some of it to them soon. It is difficult to imagine the amount of correspondence and personal contact that is essential to move even small amounts of ammunition over the many borders of Europe from the port of London.

But finally the ammunition was delivered, and the rifles were made and brought to Washington for the competition. The Thompson, the Pedersen, and the Garand were entered from the United States.

I arrived home in time to be made a member of the board to represent the Ordnance branch. James Hatcher was my small-arms expert adviser. The nine rifles were minutely examined, dismantled, assembled, fired under very fair test conditions, and eventually brought to Congress Heights for each member of the board to make a personal evaluation after firing as much as he desired. An incident happened here that was a more or less decisive factor.

Colonel O'Hara, who had fired the Pedersen rifle at Camp Benning and had much contact with the Infantry Board, showed considerable enthusiasm for the Pedersen and the caliber .276. He appeared at Congress Heights for the evaluation test in a new stiff-brimmed straw hat. He fired all the rifles standing, kneeling, and prone, coming at last to his favorite Pedersen in the prone tests. He praised its lightness and balance as he stretched out on the ground to fire, wearing his new straw hat in the bright spring sunlight.

The Pedersen rifle had a Luger-type, jointed bolt action, by which the joint lifted perhaps an inch above the breech recess at each round during the reloading and cocking action. As O'Hara fired, the rising bolt action took a nick out of the brim of the new straw hat, deepening the niche at each successive round. When he rose to express his opinion, some one suggested he examine his hat. His comments will not be repeated!

Garand Superior

The final firing-to-destruction tests at Aberdeen showed the Garand rifle to be somewhat superior to the rest. In the final sessions of the board, at which the contestants were heard and gave demonstrations, the Garand rifle was selected.

The question of caliber was reserved to the last session. I made my best appeal for the caliber .30, reciting all the long Ordnance effort in perfecting the bullet, case, materials, shape, weight, and manufacturing costs. I stressed the necessity for range, for flat trajectory, for penetration of armor, for altitude of flight against strafing airplanes, and so forth and so on. I was overruled, and the caliber .276 was recommended for adoption.

I took my disappointment to Maj. Gen. C. C. Williams, the Chief of Ordnance, and again recited all my arguments. He finally told me that from my seriousness about the matter he suspected that I would not accept the decision without further effort to defeat it. I went alone to the Army-Navy Club for lunch feeling very downhearted about my defeat and the long years of effort wasted on the best caliber known.

Decision Reversed

Then Maj. Gen. George Van Horn Moseley, Deputy Chief of Staff for General MacArthur, came along alone and asked why I was so sad, suggesting something to cheer me up. I accepted and poured out my whole story to him. He listened attentively. Two days later the decision of the board was disapproved, and the caliber .30 was established for the new rifle. Many officers still dispute the decision. The British are again considering a lighter caliber, about .276- or .28-inch.

I suppose that any of us, having so deeply committed ourselves to an idea as I have done in considering the rifle caliber, will find it very hard to change our minds and accept another caliber for the infantry arm. However, it seems to me that now when we are threatened with a great world conflict, looming ominously closer year by year, we should not discard a tried design and spend years of research to perfect a new one whose effectiveness at the target cannot be predicted to be much superior, if superior at all.

I also suggest that the former British Under Secretary had a good idea in standardizing the British arm with the arm of the U.S.A. for expeditious production and convenient supply in the field during wartime. Standardization on a well-established and effective instrument of war throughout the countries of the Western Allies is a very important phase of our common preparation to defend ourselves.

Some years ago an Ordnance Board recommended the adoption of caliber .276 for our semiautomatic rifle but this was overruled by higher authorities and caliber .30 prevailed.

Unloading ammunition at a Japanese depot (Army photo)

Army Ordnance in Japan

The Task of Storing and Maintaining Ammunition and Parts in the Far East

Brig. Gen. Gerson K. Heiss

THE two preceding articles of this series related how damaged and worn-out equipment abandoned at the end of World War II has been gathered from scattered Pacific islands for reclamation by Army Ordnance in Japan. "Operation Roll-Up" appeared in the September-October 1951 issue of ORDNANCE, and "New Trucks for Old," in the November-December 1951 issue. This vital "Operation Roll-Up," originally designed to sustain the occupation of Japan, became, after the Korean war broke out, one of the mainstays of the United Nations effort. The articles also related how these same plants have served to rebuild battle-damaged equipment from Korea. This article deals with two additional phases of ordnance activity in the Far East. One of these is ammunition; the other stock management.

Original Task

The original ammunition task was the disposition of Japanese military explosives, a herculean job involving approximately six million tons. The obvious and easiest way to dispose of such a quantity of unwanted ammunition was the simple expedient of taking it out to sea and dumping it. Three million tons were disposed of in this way. Of the remainder, a large part was demilitarized for return of the components to the Japanese economy, while the balance was retained for use by the occupation forces.

It always seems such an easy task to tear down or destroy anything, but this is not true of ammunition which requires rigid safety precautions, careful handling, and constant close supervision to prevent a major disaster.

When the war broke out in Korea, the activities of the Ammunition Division reversed themselves sharply from disposal of ammunition to that of supplying a shooting war on a large scale.

Huge Demand

Where we had been shipping out practically nothing, requirements for an active campaign rose within a few hours for shiploads of five to six thousand tons of ammunition at a time. Immediate demands were made upon the United States for delivery of additional stocks.

As vessels bringing ammunition from the U. S. increased is number, it was necessary to expand existing port facilities greatly and to open additional ports solely for the handling of ammunition. Careful scheduling had to be worked out to prevent the pile-up of incoming ammunition ships.

To prevent any overcrowding of ports and to eliminate explosive hazards at dockside, ammunition is transferred from each ship to barges of fifty to one hundred tons' capacity which then bring it to dockside where it is shipped by rail as quickly as possible to its destination.

Badly needed items have sometimes been trucked straight from dockside to aërial ports of embarkation for airlift directly to combat areas. Normally, however, it is assembled according to plan in storage areas and forwarded to the combat zone in the types and quantities required for combat operations.

Storage Space Filled

Heavy stock-piling soon overflowed existing storage space. To meet this problem it was decided to use a number of the former Japanese ammunition depots which could be reëstablished with a minimum of effort to provide the needed storage space.

Facilities Destroyed

All Japanese installations of this type had been abandoned immediately after the Japanese surrender, and in most cases facilities thereat had been either partially or totally destroyed by occupation forces for the purpose of rendering them unfit for military use.

Japanese depots were of two types: the surface storage type and the underground magazines. For surface storage the Japanese had relied in great measure on barricades between magazines rather than distance to give the safety factor that we get in the United States from our custom of widely separating surface storage buildings.

For their underground magazines it was customary to excavate deep sites from the sides of hills large enough to

receive as much as 100,000 rounds of 105-mm. ammunition or a comparable volume of other calibers.

Each magazine consists of three parts: the outer excavated cave, a concrete igloo built within this cave, and, finally, a wooden magazine erected within the igloo. When properly drained, these magazines provide excellent storage. We found several in such fine condition after five years of disuse that foodstuffs could have been stored in them safely.

Outside storage added the requirement of additional waterproofing of some types of ammunition as it was not received from the States in condition to withstand long periods of outside storage when subjected to the climatic conditions of Japan.

Research and Development

Another task that fell to the Ammunition Division was the responsibility for research, development, and local procurement of new or improvised items of explosive ordnance to fill a particular need or an immediate requirement of the combat troops in Korea.

For example, enemy night infiltration tactics created the need for antipersonnel mines which would be difficult to detect by ordinary methods. Ordnance intelligence revealed an efficient, foreign-type, wooden-box mine which, when used with U. S. Army firing devices and explosive charges, would fill the bill.

Specifications were drawn up, and the wooden boxes and the firing devices were produced locally. The mines were then assembled with explosives at ammunition depots and were on their way to Korea within a very short time after they were first requested.

As another improvisation, Ordnance devised and had manufactured locally a launcher adapter that enabled the standard infantry rifle to launch white-phosphorus grenades and flares, M49, which were available in local stocks, when the supply of rifle-launched chemical grenades became short.

In another instance, it was necessary to procure locally 50,000 trip flares which operated with a standard Army fuze. Local procurement of dynamite for demolition purposes was accomplished to save precious weeks before an emergency requisition from the Zone of Interior could be filled.

With the Korean war now well over a year old, Japan Logistical Command Ordnance is still busy receiving, storing, shipping, and exerting every effort to keep abreast of requirements in Korea.

One of the major factors that has brought success to our arms in Korea has been the ability of our combat troops to place the right volume of firepower on the enemy at the right time. Firepower means ammunition, and ammunition has kept us in Korea.

In telling the Far East Ordnance story during the period immediately preceding and during the first year of the Korean operations, there remains one other essential activity which must be covered. This is concerned with stock management.

Concurrent with the armament, automotive, and ammunition roll-up and disposition activities, mountains of spare parts and supplies were being shipped to Ordnance installations in Japan from outlying Pacific islands. It immediately became apparent that this was a rusty "gold pile" with an unknown potential.

Where to start, what to discard, and what to save could only be determined through knowledge of what we had and what was needed. To develop this, a Stock Management Division was organized in January 1949 to exercise centralized stock control.

This is the last in a series of three articles by General Heiss, Ordnance Officer, Japan Logistical Command, concerning the unique Ordnance operation that has provided a large part of the matériel support for the Korean conflict.

Parts Recorded

The identification, segregation, classification, and inventory of this "gold pile" and its subsequent recording on 80,000 stock position cards was in full operation by March 1950.

The records indicate that 140,000 tons of spare parts and supplies had been received prior to the start of the Korean operation, and 85 per cent has been reclaimed and made ready for use.

Value of the material recovered up to July 1950 in the operation was computed at $173,264,000. The average cost of processing was $16 a ton, approximately one-half the cost of shipping one ton of similar material from San Francisco to Japan.

One of the major factors responsible for keeping processing costs down was the excellent manner in which much of this material had been packaged prior to its original shipment overseas. The effectiveness of World War II packing and preserving methods have been proved through years of exposure. They have saved many a reclamation dollar after "Operation Roll-Up."

Stock Reviewed

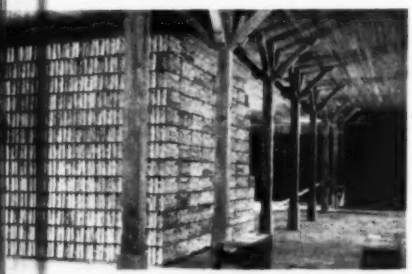
Another of the primary responsibilities of the Stock Management Division was the establishment and continual review of stock levels to support field and depot maintenance operations for, concurrent with the receipt of the Roll-Up material, the automotive rebuild program was rapidly expanding. To work out realistic general-purpose vehicle requirements and schedules, a complete survey had to be made of the status of vehicles then in the hands of troops and those in depot stocks.

Due to the age and condition of all the vehicles, normal replacement factors had to be discarded. Based on this survey, the Roll-Up rebuild schedule was set at 1,350 vehicles a month in order to provide adequate support for Army and Air Force units in the Far East Command.

To support this rebuild program, 8,430 major assemblies were required monthly. Since the field-maintenance

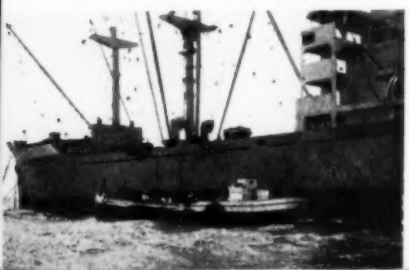
A Japanese workman identifies and tags returned Roll-Up items at Tokyo Ordnance Depot.

Segregation and repacking of reclaimed parts is done on an assembly-line basis.



Awaiting shipment to Korea, ammunition is stored in magazine, above; below, outside.

Below, barges are used to minimize danger in off-loading ammunition (All U.S. Army photos).



demands were 4,470 a month, the total major assembly requirement was established at 13,000 to support both depot and field-maintenance programs.

The rebuild of such items, however, created demands for other items and parts not available from Roll-Up stocks or from regular supply channels. It was decided, where practical and economical, to manufacture such parts locally.

Costs Compared

In so doing, many hours were spent in comparing local costs against U. S. purchase prices and shipping costs to make sure that, except in emergencies, no item was contracted for locally unless it would result in a definite saving for the United States Government.

Local procurement also required preparation locally of drawings and specifications. Arrangements also had to be made to obtain a number of raw materials which were needed but not available to Japanese industry for the program. Contracts have been negotiated successfully for, and delivery obtained of, approximately 10,000 different items and miscellaneous parts to back up the rebuild program.

The problems posed by this continuous build up of assets from Roll-Up have been many and varied. Working out priorities on which items are to be converted from "junk" to usable stocks has been an ever-recurring problem. Abnormally high demands from Ordnance units supporting the Korean operation have depleted what at one time were thought to be excess stocks.

Automatic Shipment

In the early stages of the Korean operation, immediate shipment of all types of ordnance supplies to Korea was of greatest importance. From July through October 1950, practically all supplies were sent to Korea on an automatic shipment basis. The inevitable result was the accumulation of large stocks of some items not required at all and of other items in limited demand.

This situation is being corrected and action is under way to prevent what could otherwise become another huge "roll-up." Current field-maintenance requirements and past issue history are being used to develop a restricted list of items that will be authorized for stockage in depots and field units in Korea. The thousands of items on hand in excess of these authorized lists are being recalled and distributed where needed.

This action will result in tremendous savings, not only in material involved, but also in the man-hours required to store, maintain, and record these various items.

Another peculiar problem confronting Ordnance in the Far East Command has been that of supplying spare parts to maintain vehicles of Japanese manufacture. Early in the operation it became evident there were not enough U. S. Army vehicles available either from the Zone of Interior or Roll-Up to support the Republic of Korea troops as well as our own, and therefore the bulk of the cargo-type vehicles being used by the Republic of Korea troops were procured from Japanese industry.

Stock Management ascertained the quantity of spare parts required for the maintenance of these vehicles, and action was taken to assure a steady flow of these items. The assignment of stock numbers to the parts and the revision of mortality factors are two of the more difficult problems encountered in this project.

Machines Used

To increase the efficiency of stock-control procedures within the Far East Command, manual stock records have been replaced by electrical accounting machines. The conversion to machine operations was completed in July 1951 for the Ordnance depots and the Stock Management Division of the Japan Logistical Command.

This operation is performed almost exclusively by Japanese personnel. Since relatively few understand English, operating procedures are translated and published in both English and Japanese.

The Far East Ordnance problems during the past eighteen months have been many and varied, and the solution not always easy to evolve. Coupled with the reclamation of millions of dollars' worth of equipment, and consequent savings to the American taxpayer, came the added task, under extremely difficult circumstances, of immediate and urgent support for the United Nations forces fighting in Korea.

Had it not been possible to reclaim the large quantities of unserviceable Roll-Up stocks in Japan, much valuable time would have been lost and our effort in Korea might have been seriously impeded.

The 5-ton, 6x6, cross-country truck T51

Ordnance Trucks Go Tactical

New Wheeled Vehicles Have Greater Power and Mobility

Col. W. A. Call

TO the observant spectator at the 1951 National Air Show, there was a study in contrast. An inspiring display by the Air Force appeared completely to surround and cover a few drab Ordnance wheeled tactical vehicles. Ordancemen joked about stealing the show from the Air Force, but they remained solemn because on the face of it these vehicles, which represented so much research and development, did seem humble and unimportant.

Last Link

Many people at the show stopped their thoughts at this point and devoted their time to seeing the Air Force demonstrate its prowess and power. Others, and there were many, went further than this. Perhaps a loved one was in the ground forces, perhaps he drives one of those vehicles, or has "something" to do with them. If this loved one is in the infantry, this truck is his transportation and supply medium. It is the last link in the lifeline of the soldier in combat. It is essential to him and therefore to us.

Profound Respect

The observer's sense of values reaches a higher plane. This truck receives no ovations, but without it our infantry is crippled. The onlooker moves on but takes with him a profound respect for the military wheeled tactical vehicle, and a hope—a hope that the men who design and build these vehicles realize their responsibilities.

Research Not Needed?

Occasionally one hears the suggestion that with the tremendous capacity of this country for the manufacture of trucks and other wheeled vehicles there is no need for a military research and development program or for the production of specially constructed vehicles for military use. Let us think about this.

In the design of standard commercial equipment, cost and sales appeal are of prime importance. Such a vehicle is designed primarily to do a job within the continental limits of the U. S. and to operate for the most part on fairly good roads. The objective is to produce the best possible vehicle at the lowest possible cost.

In the case of military vehicles, however, the concern is primarily with performance—with the ability to accomplish the much more difficult task for which they were designed. As a result, our military vehicles often take forms which, to the uninitiate, appear to be excessively expensive. Initial cost becomes a secondary consideration.

If by spending additional money a vehicle is produced which will carry its load—whether it be personnel, armament, ammunition, gasoline, or rations —to the proper destination, wherever that may be, under whatever conditions of terrain and weather that may exist, then we conserve precious lives and supplies. Performance, maintainability, and reliability are the goals.

Colonel Call is chief of development and engineering at Detroit Arsenal, the Ordnance automotive center at Center Line, Mich.

Two Distinct Types

Because great numbers of vehicles are used by the military forces within the United States and in its possessions, two distinct types are required—the administrative and the tactical. To a great extent the administrative vehicle, be it a sedan, truck, or motorcycle, is a standard commercial item with a coat of olive-drab paint. Parts for these vehicles are procured in the area in which the vehicle operates.

Tactical vehicles, however, present an entirely different problem. These are "all-wheel-drive, off-the-road" vehicles for troops in the field. They are entirely dependent for their spare parts upon the supply pipeline flowing continuously from the United States to the battle fronts by means of overcrowded shipping or airlift.

Standardization Essential

In this situation, the variety and quantity of spare parts required must be held to a minimum. Here stand-

	6 × 6, 4-ton Cargo Truck, W.W. II	T51 Cross-Country Carrier, Postwar	M8 Cargo Tractor, W.W. II
Pay load, tons	4	5	5
Weight empty—fully equipped less crew (lbs.)	18,050	15,850	35,500
Cargo weight to vehicle weight (%)	44	63	28
Over-all width (inches)	96	96	117
Over-all length (inches)	268⅜	254	258½
Over-all height (inches)	116½	103½	114⅝
Body size (inches)	88 × 132	88 × 147	110 × 145
Axle ground clearance (inches)	11 × 12¼	15½	18¼
Engine type	6-cyl. in-line liquid-cooled	8-cyl. opposed air-cooled	9-cyl. radial air-cooled
Gross brake hp. at r.p.m.	128 at 2,300	250 at 3,000	475 at 2,400
Maximum speed (m.p.h.)	40	55	35
Grade-speed ability (% at m.p.h.)	2.3 at 25	4.5 at 25	3 at 18
Maximum fording depth (inches)	36	72	40
Approximate cruising range (miles)	180	300	200
Torque-converter transmission	No	Yes, automatic	Yes, manual
Automatic-locking differential	No	Yes	Controlled steering ratio 1.6 to 1.0
Suspension type	Conventional (bogie-rear)	Independent torsion bar	Individual torsion bar
Service brakes	Conventional	Sealed design	External contracting
Tires	9.00 × 20, 10-ply (dual rear) military standard	14.00 × 20, 10-ply (single) tactical service	Track, steel chevron, 21 inches wide
Central inflation system	No	Yes	(Not applicable)
Generator	6-v., 25-amp.	Ordnance heavy-duty 24-v.	Ordnance heavy-duty 24-v.
Cab	Open	Open: convertible to closed (hard top)	Closed

Table I. Characteristics of the World War II cargo truck and tractor and the postwar T51 truck.

ardization is most essential, and quality of construction to eliminate the requirements for spare parts is the important consideration. Each different part requires a bin opening at the retail level, whether it be a mobile depot in the combat zone or some permanent installation.

Under extreme conditions, our vehicles operate day in and day out with little or no preventive maintenance. There is no time to stop. Oil is not changed; lubrication is intermittent. In the press of battle maintenance gives way to the prime purpose of our Army—securing the victory. The equipment has to "stand the gaff" unpampered.

Familiar Work Horse

At the beginning of the last war, standard commercial trucks had to be used as tactical military vehicles. During the course of the war these wheeled vehicles were gradually improved, and eventually there evolved that familiar work horse, the 2½-ton, 6x6, cargo truck and the larger and smaller vehicles of the same general pattern.

But these vehicles retained many of the inherent deficiencies of the commercial design. Trouble experienced in combat areas, over bombed-out rear-area roads, and in off-the-road operations gave birth to the expression, "When in doubt, use tracks." This led to the development of a large number of tracked vehicles and tractors designed to carry cargo across country and to accompany our armor.

Wheeled Tactical Vehicles

We have not yet exhausted the possibilities and capabilities of wheeled vehicles. They have many advantages over tracked vehicles, and these advantages should be properly exploited. Wheeled vehicles tend to be much cheaper, and they are inherently simpler and easier to maintain.

During the interval between World War II and the Korean emergency, the Ordnance Corps, in coöperation with industry, undertook the development of a number of wheeled tactical vehicles with the idea that they would largely supplant tracked vehicles devoted to cargo transportation. It is not anticipated at this time that wheels will supplant tracks on combat vehicles.

Serious Deficiencies

Wheeled tactical vehicles procured in World War II had several serious deficiencies. Loss of mobility was often due to the differential which permitted dissipation of the tractive effort through slippage of the least-tractive wheel. Inadequate axle clearance and poor vehicle flotation resulted in vehicles resting on their axles in deep ruts.

Combat Problems

The conventional tires of World War II vehicles were increased in size to give better flotation, but this resulted in surplus load capacity and inadequate tire life at high speeds. Conventional brake design permitted mud, sand, and salt quickly to destroy brake drums, linings, and operating mechanisms. There was a constant demand for more power. Rough riding characteristics caused unnecessary fatigue to drivers and crews.

Time-Consuming

The uncovering time in repair operations was objectionable, mechanics claiming that designers took diabolical glee in making repair tasks difficult. "Hell, yes, we can do it," they said, "but couldn't it be made easier?"

Conventional spring suspension had a high mortality. When our forces began to fight over the rough terrain and primitive roads of Korea they were equipped largely with World War II trucks. It has been estimated that prob-

ably ninety per cent of the vehicle losses in Korea have been due to spring failures.

In military actions such as this, with the battle seesawing back and forth, breakdowns too often mean a vehicle left behind and destroyed before abandonment. With an 8,000-mile supply line, it is indeed unfortunate when our troops are forced to destroy their own vehicles.

Dual Program

Since the design of the ideal wheeled tactical vehicle is a complex and time-consuming task, a dual research and development program was initiated first, to carry on the development of the ideal vehicle and, secondly, to carry on the development of a vehicle that can be produced in quantity today.

The ideal vehicles will be equipped with locking or semilocking differentials to prevent the dissipation of the tractive effort through slippage of the least-tractive wheel. The suspension may be a torsion-bar type or some other system giving increased road clearance. More clearance might be obtained with extremely large and soft tires. This will not only give a better ride, but will also increase mobility over soft surfaces. The brake system will be completely sealed.

Ordnance engineers are working to obtain more power without having excessively large engines as compared with vehicle size. The ideal design will utilize one of the standard family of Ordnance engines now developed and being built in volume in certain sizes. These engines are in the same families as those used in our present tracklaying vehicles. Incorporated with these engines will probably be some type of torque converter or automatic transmission.

Ease of Maintenance

"Ease of maintenance" has been given keen attention—and with marked success. The mechanics at the Tire Test Fleet Operations in Texas remove the complete power plant from the M34 in eighteen minutes. Consider what this means to the harassed mechanic in a combat outfit. He can replace a faulty power package in a truck with a fully serviced, tested, and tuned replacement unit, and have the truck back in operation in less than an hour.

The pay-off in this long-term research and development program lies not solely in the materialization of an ultimate vehicle but also in the interim application to current production of lessons learned and separate components developed.

The 2½-ton M34 cargo trucks and 5-ton trucks postwar vehicles are examples of this second objective. They have been improved transmissionwise by incorporation of syncromesh features. An automatic transmission for use with an alternate 2½-ton truck is also in production.

Fig. 1. The 4-ton, 6x6, cargo truck.

Fig. 2. The 5-ton M8 cargo tractor.

Fig. 3. The 2½-ton cross-country truck.

Fig. 4. The 15-ton cross-country truck.

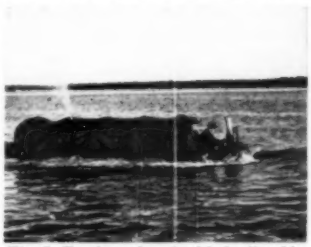


Fig. 5. Truck equipped with fording kit.

Modified Truck Engines

The engines in these production vehicles are essentially commercial truck engines modified to incorporate a 24-volt electrical system which is completely shielded and waterproofed. These engines will operate completely submerged, requiring only the addition of an air intake and an exhaust system.

While these desirable changes are being incorporated into present high-volume production models, the building and testing of experimental models of our more advanced designs continues. It will be of interest to compare one of the tactical vehicles now in the pilot stage with a World War II wheeled vehicle of similar capacity and a World War II tracked vehicle of the same capacity.

Comparison

The experimental cross-country carrier T51 (see top of page 669) has a pay load of five tons. The World War II wheeled vehicle nearest to this capacity was the 6x6, 4-ton cargo truck (Fig. 1), and the nearest tracked vehicle, capacitywise, was the M8 cargo tractor with a capacity of five tons (Fig. 2). Table I shows that the cross-country carrier with its pay load of 5 tons weighs 1½ tons less than the World War II wheeled vehicle and less than half as much as the World War II tracked vehicle. The width is the same as that of the superseded wheeled vehicle and substantially narrower than the World War II tracked vehicle.

The T51 is superior to its World War II counterparts in the wheeled or tracked categories. It has the lowest silhouette. Its ground clearance lies midway between that of former wheeled vehicles and tracked vehicles, being 15½ inches. It has twice the

horsepower of the World War II wheeled vehicle, and approximately half the horsepower of the World War II tracked vehicle.

Higher Road Speed

Its road speed is higher than that of former equipment. It will ford streams to a depth of six feet, whereas the World War II vehicles, both wheeled and tracked, were limited to a 3-foot fording depth. It has substantially greater cruising radius and will climb steeper grades at higher speed than its obsolescent counterparts. Actually the T51 appears to be a wheeled vehicle capable of keeping up with tanks over any type of terrain.

Not shown on Table I are other advantages. It provides a more comfortable ride. It is easier to drive. Maintenance is simpler. The engine embodies a completely waterproof, corrosionproof, fungiproof, dustproof, and radio-interference-proof 24-volt ignition system which is far superior to the conventional 6-volt system.

In addition to the T51, there is under development at the present time a class of cross-country carriers consisting of ¾-ton, 4x4, trucks; 2½-ton, 6x6, trucks (Fig. 3); and 5-ton, 6x6, cargo vehicles. The outstanding features of these vehicles are the air-cooled, horizontally opposed engines, members of the Ordnance "family of engines" with interchangeable parts, torque-converter planetary-gear transmissions, and improved suspension systems. Certain special features are being tested on some of these vehicles, such as fuel injection and front and intermediate wheel steering in one of the 5-ton trucks.

Highly Mobile Vehicles

The cross-country carriers are envisaged as highly mobile vehicles which would be procured in relatively small quantities for use by front-line troops. The air-cooled engine powering this group of vehicles has cylinders, pistons, connecting rods, bearings, and other auxiliary parts interchangeable. This will alleviate substantially our parts-supply and stocking problems.

In larger vehicles we are developing 8x8 trucks with capacities of ten and fifteen tons (Fig. 4). These provide good load distribution and an excellent ride due to the additional bogie in front as well as the usual bogie at the rear. They, too, are equipped with air-cooled engines and torque-converter, planetary-gear transmissions.

These large vehicles utilize an 8-cylinder, V-type, air-cooled engine with the same piston, connecting rod, and basic cylinder as is used in the tanks and the self-propelled artillery. These 8x8 trucks are demonstrating their ability to go anywhere a tank can go, and are expected to be produced in both tractor and cargo versions—the one to be utilized for towing semi-trailers and the other to serve as a prime mover for heavy towed artillery.

Performance Requirements

Like the commercial automotive industry, the Detroit Arsenal Development and Engineering Department receives requirements from its customers. A few of the performance requirements demanded by these customers are:

1. The vehicles must have the ability to climb a sixty per cent slope with rated load—this slope, of course, to consist of a natural, unpaved hill.

2. They must be able to maintain a reasonable road speed compatible to the size of the truck. By this requirement our customers mean that the truck, regardless of size, will have to be capable of sustained operation at thirty-five miles an hour or better.

3. The vehicles must be capable of continuous operation on a twenty per cent side slope.

4. They must be able to travel 300 miles at 30 miles an hour without refueling.

5. They must be able to ford streams with the water up to the driver's neck.

6. The differentials must provide drive to all wheels having traction.

7. A full floating axle is desirable.

8. They must have the maximum obtainable ground clearance and, at the same time, the lowest possible silhouette.

9. The vehicles must be able to operate with flat tires without losing the tires.

10. They must be able to operate at any temperature from 65 degrees below zero Fahrenheit to 125 degrees above.

11. In addition, all vehicles must be designed to be capable of being air-transportable, and they must be provided with the necessary lifting eyes and tie-down hooks to permit easy loading on both ships and aircraft.

In addition to these major performance requirements the Ordnance Corps, which is charged with the maintenance and supply of spare parts for these vehicles, demands a maximum interchangeability of parts and a minimum amount of maintenance. The Quartermaster Corps, which supplies the fuel, demands a minimum fuel consumption on all vehicles. In connection with this, the new vehicles are designed to operate on 80-octane fuel, but at the same time they must be capable of operating on 72-octane fuel without harmful effect.

In addition to the requirements mentioned previously, the design should call for a minimum of critical materials and be capable of volume production at a minimum cost.

In order to cut the cost of our vehicles, we plan to utilize various kits. These will enable us to equip a vehicle for a specific military application when required. Some of these kits are the deep-water fording kit, consisting of intake and exhaust stacks, to enable vehicles to negotiate streams up to the depth of its driver's neck (Fig. 5).

To enable our vehicles to operate at extremely low temperatures we have three arctic kits: the hard-top cab, which consists of an insulated metal top to replace the standard canvas one; a personnel-heater kit designed to furnish adequate warmth and defrosting at 65 degrees below zero Fahrenheit; and a power-plant heater kit which provides stand-by heat in extremely cold weather.

Substantial Savings

Since the manufacturers and the Ordnance Corps have no indication as to a delivered vehicle's theaters of operation, it is evident that the use of kits results in substantial savings. Consideration is, therefore, given in vehicle design to easy application of these kits.

Despite the many complex requirements to be met and the difficult problems remaining to be solved, we are confident that Ordnance, with the help of the unequaled engineering organizations of the vast automotive industry, will continue to provide the world's best vehicles to our armed forces. Moreover we will see the cheaper and more easily built wheeled vehicles venturing ever further into the territory where formerly only tracked vehicles dared to tread.

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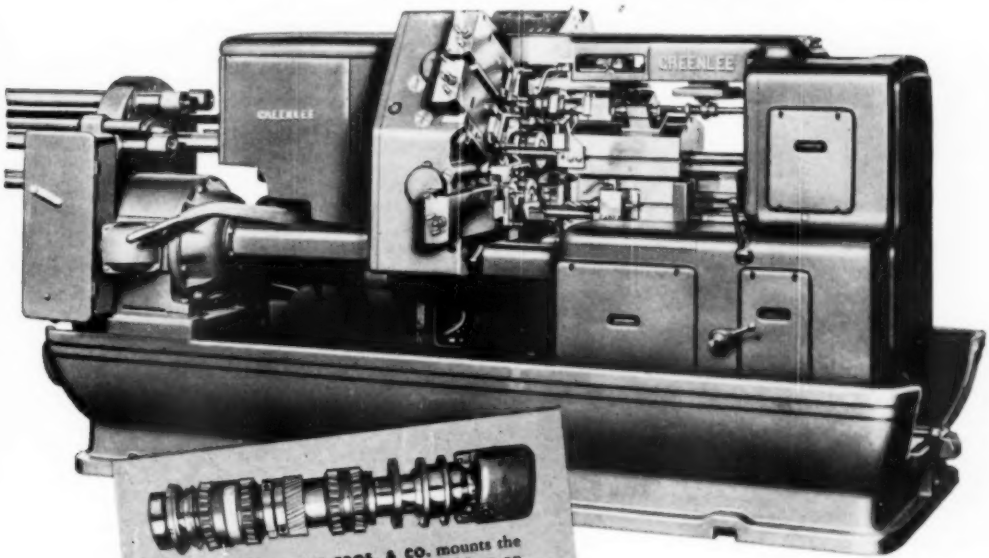
Since Timken bearings are engineered for the job, precision manufactured and made of special analysis Timken fine alloy steels, they normally last the life of the machine.

No other bearing can give you all the advantages you get with Timken tapered roller bearings. Make sure you have them in every machine tool you build or buy. Look for the trademark "Timken" on every bearing. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.



How the **GREENLEE BROS. & CO.** mounts the spindles of its automatic screw machines on Timken bearings to insure lasting precision.

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Finishing to incredible smoothness accounts for much of the precise, smooth rolling performance of Timken bearings. This honing operation is typical of the amazingly accurate manufacturing methods at the Timken Company.

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Photo by Maslowski from National Audubon Society

Match wits with Mustela

Meet *Mustela longicauda*, the long-tailed weasel. After he puts away the rest of that rabbit, his next objective may be some unlucky farmer's henhouse. There he can kill to his heart's content, slashing the throats of a score or more hens before his blood lust is sated.

No doubt about it—he's a predator. The sportsman can have a good time matching wits with *Mustela*, for the weasel knows all the tricks of flight and concealment. Don't try to eliminate the weasel in your area completely, however, for he also helps maintain nature's balance by keeping field mice and rats in check. See your local game regulations, too, before shooting the weasel.

Besides controlling predators like the weasel, good sportsmen can do their part in conserving our game supplies by joining and actively supporting local and national conservation organizations.

N.R.A. RANGER

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